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Parasites of fishes of Družno Lake

[Parasitofauna of the biocoenosis of Družno Lake — part VIII]

Pasożyty ryb jeziora Družno

[Parazytofauna biocenozy jeziora Družno — część VIII]

The primary objective of my work was to establish the parasitic species typical of, and numerically dominant in, the biocoenosis of Lake Družno, and the elements marginal and accidental in that biocoenosis, and to show periodical changes in the occurrence of the parasites.

I carried out the investigation of fish parasites of that lake in the summer months (July, August and September) and ten days in the spring (May) and the autumn (November) in the years 1950—1953.

Fishes are one of the major components of the biocoenosis of Lake Družno. Invaded to a high degree, mainly by larval forms of flukes, they constitute a food basis of other fishes, piscivorous mammals and birds. In this connection it is very important from the point of view of circulation of parasites to establish the fauna of their parasites.

Both the composition of the fauna of fishes and their parasites are closely related to the conditions of the external environment. Družno is a large, shallow, overgrown lake like a pond. It is connected with Vistula Bay and through it with the Vistula, Nogat and the Baltic Sea. It constitutes a bird reserve.

The composition of fishes in the lake is decided by the eutrophic character of the lake on the one side and its communication with Vistula Bay, the Vistula and the sea, which enables fishes theoretically alien to its character to penetrate to Družno on the other.

As gathered from samples obtained in season between 1950 and 1953 the composition is as follows:

Osmerus eperlanus L., *Esox lucius* L., *Rutilus rutilus* (L.), *Scardinius erythrophthalmus* (L.), *Tinca tinca* (L.), *Aspius aspius* (L.), *Gobio gobio* (L.), *Alburnus alburnus* (L.), *Blicca björkna* (L.), *Abramis brama* (L.), *Rhodeus sericeus amarus* (Pall.), *Carassius carassius* (L.), *Cyprinus carpio* (L.), *Cobitis taenia* (L.), *Misgurnus fossilis* (L.), *Anguilla anguilla* (L.), *Lota lota* (L.), *Pungitius pungitius* (L.), *Perca fluviatilis* (L.), *Lucioperca lucioperca* (L.), *Acerina cernua* (L.), *Pleuronectes flesus* (L.).

Among the above twenty-two species, *Cyprinus*, *Lota*, *Aspius*, *Lucioperca*, and *Osmerus* are very rare in the lake and come from the Bay, the Vistula and perhaps from the Nogat. The connection with the sea is proved by *Pleuronectes flesus*, of which several specimens occur.

While it is easy to determine the qualitative composition of the fishes at Družno, it is difficult to ascertain their number because of their continuous migrations and because the exploitation of the lake is being carried on from the point of view of certain species. That the exploitation affects certain species more than others may be gathered from Table I, which shows the results by the kilogram of the catches in 1947 to 1950.

Table I
Catches in kgs in 1947—50

Species	1947	1948	1949	1950	Total
<i>Esox lucius</i>	35,781.5	5,880.0	12,929.0	5,093.5	59,684.0
<i>Rutilus rutilus</i>	13,068.0	11,090.0	12,384.0	7,850.0	44,392.0
<i>Abramis brama</i>	2,136.0	2,681.0	14,016.0	4,951.0	23,784.0
<i>Tinca tinca</i>	6,344.5	4,187.5	6,128.0	2,552.5	19,212.5
<i>Perca fluviatilis</i>	3,445.0	3,238.5	1,914.0	1,180.0	9,777.5
<i>C. carassius</i>	1,505.5	2,405.5	1,899.0	402.5	6,212.5
<i>Blicca björkna</i>	—	1,167.0	3,242.0	5,732.0	10,141.0
<i>Cyprinus carpio</i>	—	—	190.0	187.5	377.5
<i>L. lucioperca</i>	—	19.5	109.0	1.5	130.0
<i>A. anguilla</i>	27	—	53.5	41.0	121.5
Total	62,307.5	30,669.0	52,864.5	27,991.5	173,832.5

It follows from the table that the exploitation of one and the same species (*Tinca*, *Esox*) varies from year to year, the differences amounting to several hundred per cent. These differences prove not so much that there were two or three times as many adult fishes of a given species at a given time as that the species in question was more intensely caught that year. Consequently only general conclusions on the numerical occurrence of various species may be drawn on the evidence of the catches.

The total catches shown in the table also warrant the conclusion that among the nine species caught at Lake Družno, seven — *Esox*, *Rutilus*, *Abramis*, *Tinca*, *Perca*, *Carassius*, *Blicca* are species characteristic of the lake and that *Esox*, *Rutilus* and *Blicca* may be regarded as dominant in its waters. But even when assessing things so very generally it should be borne in mind that the relation between the totals of *Blicca* and *Abramis* may not be accurate, as the fishermen do not separate these two species when sorting small fish and report small specimens of *Abramis* as *Blicca*.

What is striking at Družno is a great number of predatory fishes — *Esox* and *Perca*, the former amounting to 50—60% on the average. The third predatory fish species, *Lucioperca*, is very scanty and accidental in the lake. Among other things the degree of transparency of water does not probably suit it.

Even a relative assessment of the numerical composition of the fishes in the lake is complicated still more by their migrations. These may — in the opinion of Mr. A. Malicki, head of the SGGW Fishery between 1957 and 1951 — be periodical or due to some unexpected circumstances.

One such mass migration was observed in 1947 and it was caused by the shallow regions of the lake becoming frozen down to the bottom. Fishes began to return to the then almost empty lake in spring. *Esox* came in April and *Abramis* in May.

According to Mr. Malicki similar migrations yet on a smaller scale are a constant phenomenon at the lake. He has also informed me that *Esox*, *Abramis* and *Rutilus* come to spawn at the lake from Vistula Bay, and the local *Esox*, *Rutilus* and *Abramis* spawn here. *Abramis*, *Rutilus* and *Anguilla* partly go to the Bay in winter and also one-year-old and two-year-old (O+ and 1+) fry, chiefly *Abramis*, is supposed to go there in autumn.

Table II

Number of adult fishes and fry examined at Lake Družno in 1950 to 1953

No.	Species	Number of examined				
		1950	1951	1952	1953	Total
1.	<i>Esox lucius</i>	29	34	—	—	63
2.	<i>Rutilus rutilus</i>	27	23	37	—	87
3.	<i>Scardinius erythrophthalmus</i>	17	5	20	9	51
4.	<i>Aspius aspius</i>	2	—	—	—	2
5.	<i>Tinca tinca</i>	16	99	1	2	118
6.	<i>Gobio gobio</i>	5	5	—	—	10
7.	<i>Alburnus alburnus</i>	4	1	—	50	55
8.	<i>Blicca björkna</i>	19	52	14	—	85
9.	<i>Abramis brama</i>	26	63	4	30	123
10.	<i>Rhodeus sericeus</i>	18	—	—	21	39
11.	<i>Carassius carassius</i>	10	6	—	—	16
12.	<i>Cobitis taenia</i>	1	—	—	—	1
13.	<i>Misgurnus fossilis</i>	—	2	—	—	2
14.	<i>Anguilla anguilla</i>	1	1	—	—	2
15.	<i>Lota lota</i>	1	—	—	—	1
16.	<i>Pungitius pungitius</i>	—	2	—	—	2
17.	<i>Perca fluviatilis</i>	44	45	26	—	115
18.	<i>Lucioperca lucioperca</i>	6	2	—	—	8
19.	<i>Acerina cernua</i>	21	2	—	—	23
Total of adult fishes		247	340	102	112	801
Cyprynid fry		—	355	106	126	587
Total of adult fishes and fry		247	695	208	238	1388

Methods of treatment and catching technique

During my stay for many months at the lake in the period between 1950 and 1953 I examined a total of 1,388 fishes and fry, 340 among them in search of definite species, e.g. *Caryophyllaeus laticeps*, *Neascus scardinii* and others (Table II). Most fishes were invaded and 96 were quite free from parasites.

The fishes were taken from catches made with a sweep-seine and a casting-net at various points of the lake. The fishes were measured to determine their age and examined in an accepted order. The parasites found, except for *Ciliata* and *Myxosporidia*, were counted as accurately as possible. 75% alcohol was used for preservation, stained with boracic carmine. Preparations were usually mounted in balsam, less frequently in gelatine.

Of various systematical groups the major emphasis was laid on *Digenea*, *Acanthocephala* and *Cestoda*. As other members of my

research team are to work on my findings, materials and preparations of *Acanthocephala* and *Caryophyllaeidae* I do not discuss these groups.

In addition to adult fishes I examined fry, above all the youngest age classes (0+). The youngest fry was caught with a tulle net, the older with fine-meshed nets used by fishermen to catch.

The fry consisted exclusively of various species of *Cyprinidae*. It was treated as a collective unit because of difficulties in the determination of it. I failed to obtain the youngest age-class of *Perca* and *Esox*.

In the course of my research I found four species of metacercariae parasitic in the eyes and brains of fry. Two of these — *Posthodiplostomulum brevicaudatum* (Nordmann, 1832) Kozicka n. nov. and *Neascus scardinii* (Schulmann) are new in Poland. Two others, *Tetracotyle* sp. sp., have not apparently been described as yet. They will be described elsewhere. The occurrence of these metacercariae in fry and their influence on the youngest age-classes I have explained elsewhere (Kozicka, 1958).

Fish parasites in the biocoenosis of Lake Družno

The parasites found in fishes belonged to *Protozoa*, *Monogenea*, *Digenea*, *Copepoda parasitica*, and *Mollusca*. The components of the fish parasitocoenosis were determined on the evidence of the number of parasites occurring. The criterion was the extensity and intensity of the occurrence of parasites in hosts. The extensity, intensity and index of invasion were a basis of the division of parasites into common and infrequent. Moreover, three dominant forms were distinguished among the former.

The following ranked with the common parasites: (a) flukes — particularly their larval forms; (b) tapeworms of the family *Caryophyllaeidae* and larvae of *Ligula intestinalis*, (c) *Copepoda parasitica* (*Ergasilus sieboldi* Nordm.). *Nematodes*, *Acanthocephala* and other tapeworms were infrequent elements.

Taxonomical and numerical survey of parasites

MYXOSPORIDIA

Among the protozoans parasitic in fishes, *Myxosporidia* occupy a dominant position at Družno. Except for the most common and

best known of them I determined them only down to genus. Most of them represent the genus *Myxobolus*, two species belong to the genus *Myxidium*, one to the genus *Henneguya* (Table III).

Myxobolus sp. was found in *Esox*, *Rutilus*, *Perca*, *Carassius* and *Abramis*; *Myxidium lieberkühni* Bütschli in *Esox*; *Myxidium* sp. in *Rutilus* and *Scardinius*; and *Henneguya psorospermica* Thel. in *Esox* only.

Myxidium lieberkühni Bütschli, 1882

Large red plasmodia and spores characteristic of the genus *Myxidium* were found at Družno in ca 50% of the *Esox* examined between 1950 and 1951 (Table III). It occurred in the bladder and ureters in *Esox* and, less frequently, in *Lota*.

The range of occurrence of *M. lieberkühni* covers Western Europe, the European and Siberian part of the Soviet Union, and North America (Markewitsch, 1951).

Outside Družno I found it in Poland in *Esox* both from the Vistula and Lakes Tajty, Harsz, Mamry, Kortowo, Łabędzie and Oświn.

Myxidium sp.

Myxidium sp. cysts small and yellowish, resembling the Malpighian glomeruli in external appearance. Spores similar to those of *Myxidium lieberkühni*, yet somewhat shorter and narrower than they. They occurred in *Rutilus* and *Scardinius* at Družno. Outside Družno I found them in the kidneys of *Rutilus*, *Scardinius*, and, less frequently, in *Abramis* at Lakes Tajty (Kozicka, 1951) and Łabędzie.

Genus *Myxobolus* Bütschli, 1882

The genus *Myxobolus* is undoubtedly represented at Družno by several species which I did not describe in detail.

I found cysts of these species mostly in the gills of adult fishes. Their presence in the internal organs of older fishes was discovered three times only, twice in *Carassius* (internal organs) and once in *Scardinius* (muscles).

The percentage of invasion in some hosts is fairly high (Table III), invasion intensity widely varying, usually from 1 to 38 large

In fry, cysts and spores of the genus *Myxobolus* were found almost only in the muscles.

At Družno, large smooth white cysts of the parasite were observed only in *Esox*. Invasion percentage amounted to 22.2 in the years 1950—51, intensity varied from 1 to 47 cysts on both sides of the gills.

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Outside Družno, I observed it in a number of lakes in Mazury on the gills of *Esox* and *Perca* mostly from late autumn to the end of winter.

It follows from the figures shown in Table III that the fish species most characteristic of Lake Družno — *Esox*, *Abramis*, *Scardinius*, *Rutilus*, *Perca*, *Blicca*, and *Carassius*, are invaded by *Myxosporidia* of the genera *Myxidium*, *Myxobolus* and *Henneguya*.

The very high invasion extensity and intensity of these species make it possible to regard *Myxosporidia* as parasites fairly characteristic of Družno Lake.

CILIATA

Ciliata are represented at Lake Družno by the genera *Ichthyophthirius*, *Chilodonella*, *Trichodina*, and *Trichodinella*. Moreover, an invasion by the epizoid form *Glossatella* sp. was observed on the gills of older fishes and in the oral cavity and branchial pouch of fry.

Ichthyophthirius multifiliis Fouquet, 1876

This largest of the protozoans parasitic in fishes was found in the gills of *Abramis*, *Rutilus*, and *Blicca* at Družno Lake. Invasion percentage was low (Table IV) and so was invasion intensity. It varied from 1 to 17. The maximum invasion, 25 specimens of the parasite, was observed in *Rutilus*. As regards fry, invasion was observed in ten out of the 355 specimens examined in 1951, the invasion index in fry being somewhat lower than in older fishes, and the number of parasites usually not exceeding 5.

The presence of parasites was observed in July, August, and September, but no parasites were discovered in May and November. The absence of *Ichthyophthirius* in those months may be ascribed not only to the assumed decrease in invasion but also to a smaller number of fishes examined during the short summer and autumn research periods.

The other alternative is favoured by the fact that in *Abramis* from the Vistula near Warsaw the presence of *I. multifiliis* was observed throughout the research period, i.e. from the beginning of April to the end of November (Kozicka, 1951). This coincides with the observations made by Ščupakov (1954), who observed the presence of *I. multifiliis* in fishes throughout the year

Table IV
Ciliata — invasion of adult fishes in 1950—1951

Host	Year	No. of fishes examined	<i>Ichthyophthirius multifiliis</i> Fouquet			<i>Trichodina domer- guei</i> Wallengreen + <i>Trichodinella epi- zootica</i> (Raabe)			<i>Trichodina urinaria</i> Dogiel			<i>Chilodonella cyprini</i> Moroff			<i>Glossatella</i> sp.		
			In- vaded	%	Inten- sity	In- vaded	%	Inten- sity	In- vaded	%	Inten- sity	In- vaded	%	Inten- sity	In- vaded	%	Inten- sity
<i>Esox lucius</i> L.	1950 1951	29 34				7 1	27.1 2.9	single or mass				2 1	6.0 2.9	single or mass			
<i>Rutilus rutilus</i> (L.)	1950 1951	27 23	1	4.3	2	3	3.0							not nu- merous	1	4.3	not nu- merous
<i>Blicca björkna</i> (L.)	1950 1951	19 9	1	11.0	3		1.5										
<i>Abramis brama</i> (L.)	1950 1951	26 23	3	3.0	2—5							1	11.1	30			
<i>Carassius carassius</i> (L.)	1950 1951	9 6				4 1	14.4	single									
<i>Lucioperca lucioperca</i> (L.)	1950 1951	6 2				2		fairly nu- merous									
<i>Perca fluviatilis</i> L.	1950 1951	44 14									nume- rous						

and regarded a temperature of 16 to 22° C. as an optimum for its development.

Outside Družno I met *I. multifiliis* not only in pond fisheries, but in rivers and a number of lakes.

As the number of invaded fish species and invasion intensity are small, *I. multifiliis* may be regarded as a parasite rather rare in the biocoenosis of the lake.

Chilodonella cyprini (Moroff, 1902)

Chilodonella cyprini was found in Družno only in 3.2% of the *Esox* and 6.6% of the *Carassius* examined in 1950 and 1951. All the specimens found showed cordiform cuts on the dorsal side of the body which are supposed to distinguish *Ch. cyprini* from *Ch. hexasticha* Kiernik, 1909 (after Prost, 1952), a species related to it.

It used to be questioned for a long time whether these two species were different. Nowadays most authors, e.g. Kudo (1947), Doflein (1933), Dogiel (1932), and Schäperclaus (1954), quote both. Having analyzed the differences in the shape of the body and the silver-absorbing system in both the species in 1952, Prost decided that they were definitely different species.

According to Markewitsch (1951) the range of occurrence of *Chilodonella cyprini* covers the whole of the Palaearctic and Nearctic.

We have found it in Poland fairly often, sometimes in great numbers in *Cyprinus* and *Salmo* in pond fisheries and relatively seldom, anything up to 30% in Vistula fishes.

At Družno it occurred in so small a proportion and in so small numbers of specimens (Table IV) that it should be regarded as one of the infrequent parasites in the biocoenosis of Družno.

Trichodina domerguei Wallengren, 1897

It was found in 2.7% of *Esox*, 6.2% of *Rutilus*, 33% of *Carassius* and 2.5% of *Lucioperca* examined in 1950—51 (Table IV). In fry it was found in 12 specimens out of 355 examined in 1951. The size of the parasites usually varied between 50 and 60 μ , while the number of links in the crown was anything between 19 and 30. The centripetal spikes of the crown were long and distinct. No "cirri" were observed on the aboral side at the cilia.

Trichodinella epizootica (R a a b e, 1950)

The size of the parasite is half or sometimes more than half the size of *Trichodina domerguei*. The parasite itself seems — according to what R a a b e suggests — to be less mobile, more delicate and transparent than the previous form and just as this form it has no "cirri" on the aboral side of the body. No centripetal spikes appear in the crown. *Trichodinella epizootica* usually occurs together with *Trichodina domerguei*.

Trichodina urinaria D o g i e l, 1950

It was found in the urinary bladder of *Perca* once in 58 specimens examined in 1950—51. The size of the parasite generally corresponds to that of *T. domerguei*. The number of links in the crown amounted to over 40. The parasite body was delicately greenish in hue and seemed more transparent and thicker than *T. domerguei*.

In Poland it was observed for the first time at Družno as a very rare parasite.

MONOGENEA

Monogenea are represented at Družno by the genera *Dactylogyrus*, *Ancyrocephalus* and *Tetraonchus* (*Dactylogyridae*), *Diplozoon* (*Discocotylidae*), and also by *Gyrodactylus* sp. in fry.

With the exception of the most common and best known of them I determined *Monogenea*, as I did *Sporozoa*, down to genus only.

They are a very numerous group of fish parasites at Družno. Out of the 19 fish species examined in 1950 and 1951 twelve, or two third proved to be invaded by them. It is very likely that they were not observed in some of the remaining eight species because considerably fewer of them were examined.

Genus *Dactylogyrus* D i e s i n g, 1850

The genus *Dactylogyrus* consists at Družno of several species which I did not describe in detail. It follows from statistics (Table V) that Cyprinid fishes are the chief host of the parasites of the genus *Dactylogyrus* at Družno.

On the basis of the above findings the parasites of the genus *Dactylogyrus* may be regarded as characteristic of Družno.

Ancyrocephalus paradoxus Creplin, 1839

Gill parasite specific to *Lucioperca* and *Perca*. At Družno found only in *Perca*. As the percentage of invasion is low and intensity very small it may be regarded as a rare parasite at the lake.

The range of occurrence covers Central and North Europe, and USSR.

Tetraonchus monenteron (Wagener) Diesing, 1858

Parasitic on the gills, specific to *Esox*. As the percentage and intensity of invasion are low it may be regarded as one of the parasites little characteristic of the lake.

The range of occurrence of *T. monenteron* covers both Palaeo- and Nearctic.

It is very common in Poland both in river and lake *Esox*.

Diplozoon paradoxum Nordmann, 1832

Occurring chiefly in Cyprinid fishes. The percentage and intensity of invasion (Table V) make it possible to assign it among the parasites little characteristic of Družno.

Recorded in Western Europe and in the European and Asiatic part of the Soviet Union; common in Poland.

DIGENEA

Bucephalidae proved to be the dominant fish parasites at Lake Družno. At first I identified them as *Bucephalus polymorphus* Baer, 1927, later I began to distinguish two forms among them either of which belonged to a different genus of the family *Bucephalidae* Poche, 1907. I identified the larger one as *B. polymorphus*. It had extrusive tentacles before the oral sucker; vitellaria of varying length, reaching the hind part of the body; a pharynx usually directed towards the front of the body. The other, *Rhipidocotyle illense* (Ziegler, 1883), smaller, had a „cowl” instead of tentacles which covered the dorsal part of the oral sucker and sometimes widened like a fan; vitellaria of the same length limited to the front half of the body and a pharynx usually running from the gut backward.

B. polymorphus was very rare at the lake. Several up to a score of specimens of the definite form were found in the intestine of

Lucioperca from Vistula Bay and single specimens very seldom in the intestine of *Esox*. On one occasion only I found 16 specimens of their metacercariae in the intestine of *Blicca*. On the other hand *Rh. illense* occurred heavily at the lake. Up to several thousands of their definite form were found in the intestine of *Esox*, and several in the intestine of *Perca* and *Acerina* on rare occasions. Their metacercariae occurred almost in all fish species and in some of them heavily.

Both above parasites discovered at Družno Lake had been long known and described in Europe, but always as one and the same species — *B. polymorphus* (W ag e n e r, L ü h e, E c k m a n, Z i e g l e r). This was accounted for on the one hand by a conviction that only one representative of the family *Bucephalidae* — *B. polymorphus* B a e r, 1827 — occurred in fresh waters in Europe, and by the striking similarity in internal structure with the external characteristics distinguishing *Bucephalus* and *Rhipidocotyle* being difficult to grasp. When the tentacles characteristic of the genus *Bucephalus* are hidden in the sucker and the „cowl” characteristic of *Rhipidocotyle* does not spread, both parasites are so similar to each other that they cannot be distinguished at first sight.

The short historical outline of the investigations given below explains the reasons for errors in the classification of these parasites committed for over a hundred years now.

The first representatives of the family *Bucephalidae* were described by R u d o l p h i as early as 1819 under the name of *Monostomum crucibulum*. B a e r first introduced the generic name of *Bucephalus* in 1827. In 1848 S i e b o l d found in the intestine of *Perca* and *Lucioperca* a fluke possessing a mouth opening on the ventral side of the body and a „fimbria” before the oral sucker, and introduced the generic name of *Gasterostomum*. On the basis of similarity in the internal structure he suggested that „le *Bucephalus polymorphus* est probablement un Gasterostome a l'état de larve”.

In 1845 D u j a r d i n found in the intestine of *Esox* a fluke possessing on the anterior side of the body a sucker „en forme de cloche, finement plissée mais non lobée” which he called *Distoma campanula* and believed that small helminths encysted on the gills of *Cyprinus idus* and possessing the same sucker are immature forms of *Distoma campanula*. Thirteen years later W e d l (1858) discovered in the intestine of *Esox* a fluke which he identified

Table V
Monogenea — invasion of adult fishes in 1950 and 1951

Host	Year	No. of fishes examined	<i>Dactylogyrus</i> sp.					<i>Diplozoon paradoxum</i> Nordmann				
			Invaded	%	Index of invasion	No. of parasites	Intensity	Invaded	%	Index of invasion	No. of parasites	Intensity
<i>Rutilus rutilus</i> (L.)	1950	27	16	59.2	20.3	326	2—39	1	3.7	2	2	2
	1951	23	3	13.0	6.3	19	1—11					
<i>Sc. erythrophthalmus</i> (L.)	1950	17	11	64.7	24.7	272	1—80	1	5.9	3	3	3
	1951	5	1		5	5	5					
<i>Aspius aspius</i> (L.)	1950	2	1		90	90	90					
	1951											
<i>Tinca tinca</i> (L.)	1950	16	1	6.3	3	3	3					
	1951	12										
<i>Gobio gobio</i> (L.)	1950	5						1	20.0	1	1	1
	1951	5										
<i>Alburnus alburnus</i> (L.)	1950	1	1		10	10	10					
	1951	4										
<i>Blicca björkna</i> (L.)	1950	19	5	26.3	22.4	112	12—38	4	2	3.7	15	2—7
	1951	9	2	22.2	2	4	1—3					
<i>Abramis brama</i> (L.)	1950	26	15	57.6	30.4	457	1—78	12	16.1	3.5	43	1—7
	1951	23	7	26.0	9.4	66	2—19	1	47.8	5.1	57	1—11
<i>Carassius carassius</i> (L.)	1950	9	5	55.6	22	110	9—40					
	1951	6	2		4	8	1—7					
<i>Perca fluviatilis</i> L.	1950	44						<i>Ancyrocephalus parodoxus</i> Creplin				
	1951	14						2	3.5	1.3	3	1—2
<i>Esox lucius</i> L.	1950	29						<i>Tetraonchus monenteron</i> Diesing				
	1951	34						2	6.9	2.5	5	2—3
								4	11.7	12.7	51	1—30

with *Distoma campanula*, and presented a drawing not given in Dujardin's work. It may be gathered from the size of the parasites, the presence of „zwei derbe Hervorragungen" on the sides of the sucker, and the position of the sucker (pharynx) behind the middle of the body that the author dealt with *Rhipidocotyle* sp. Wagener found in 1852 *Gasterostomum fimbriatum* Siebold, 1848 in the intestine of *Esox*, gave a description of the tentacles, the number of which he fixed as five, observed additional convexities at their base and presented (1858) drawings of the parasite with extruded and withdrawn tentacles. As he was sure that *Gasterostomum fimbriatum* occurred in *Esox*, and perhaps persuaded that the tentacles became invisible under certain circumstances, he considered *Distoma campanula* identical with *G. fimbriatum* and assigned them to the synonyms of the latter. At the same time he confirmed the suggestion that *B. polymorphus* was a larval form of *G. fimbriatum*.

Wagener's investigations supplied a basis for the conclusion of later authors that only *G. fimbriatum* with the larval form *B. polymorphus* occurred in Europe. On finding *Rhipidocotyle* sp. in *Esox*, Ziegler (1883) presented — on this assumption — an accurate description of the species, a very good drawing and a histological analysis of the muscle-striped „cowl" characteristic of *Rhipidocotyle*; he was first to effect an artificial invasion for which he used cercariae „generally known as *Bucephalus polymorphus*" as the working material, obtained metacercariae and made an anatomical and histological analysis of cercariae and metacercariae. What worried him however was that the cercariae he used were smaller than those described by Baer in 1827 and that he found no tentacled fluke in the *Esox* he sampled from various places in the basin of the river Ille. He passed over the size of cercariae, but since there were no tentacles he writes that „as all other findings of Wagener's coincide with mine, I believe that the fimbriae form under abnormal conditions" and added that „if the *Gasterostomum* tentacles prove a normal and permanent phenomenon, the forms found in the basin of the river Ille ought to be regarded as a new species which could be called *Gasterostomum illense*".

It followed from Ziegler's work that in addition to *B. polymorphus* one more species without tentacles and with a „cowl" on the dorsal side of the hind part of the oral sucker occurred in the European inland waters undoubtedly of the genus *Rhipido-*

cotyle and that there were probably two species of cercariae very similar to each other of which the bigger might be a larval form of *B. polymorphus* and the smaller a larval form of *Rhipidocotyle*. Yet because of Ziegler's indecision, due perhaps to his failure to encounter a spread fan of the „cowl”, the representative of the genus *Rhipidocotyle* he described as *Gasterostomum fimbriatum* was ignored.

In 1905 Odhner created the suborder *Gasterostomata* and joined together the genera *Gasterostomum* and *Rhipidocotyle* into one genus *Gasterostomum* and regarded „*Gasterostomum fimbriatum*, so well described by Ziegler” as a representative of the genus.

Meanwhile, on the basis of priority Poche (1907) changed the name of the family *Gasterostomidae* Braun, 1893 to *Bucephalidae* Poche, 1907. He was supported by Eckmann (1932), Nagaty (1937), and Dawes (1946). In 1909 Lühe described *Rhipidocotyle illense* and called it wrongly *Bucephalus polymorphus* Baer, 1827. He added that it was the only representative of *Bucephalidae* in the fresh waters of Germany. Eckmann (1932) was of the opinion that „Ziegler wies die Identität der Gattung *Bucephalus* und *Gasterostomum* und daher muss die Gattung *Gasterostomum* als Synonym der Gattung *Bucephalus* dienen” and assigned the form described by Ziegler (*Rhipidocotyle*) to the synonyms of *B. polymorphus*. The result was that *Rh. illense* ceased to be taken into consideration as an independent species.

Only when *B. polymorphus* and *Rhipidocotyle* are found at the same time, they can be distinguished. They were found by Kowal in the Dnieper in 1949, myself at Družno in 1950, and Vejnar in Czechoslovakia (1956). Kowal however assigned both species to one and the same genus *Bucephalus* Baer, 1827, and described one of them as *Bucephalus markewitschi*, leaving the other (*Rhipidocotyle*) with the generally accepted but erroneous name of *Bucephalus polymorphus* Baer, 1827. On the other hand, Vejnar (1956) denoted the tentacled parasite as *B. polymorphus* and gave the parasite without tentacles the right name of *Rh. illense*, yet presented no dimensions or drawings. I consider the representatives of *Bucephalidae* I have found to be *B. polymorphus* Baer, 1827 and *Rhipidocotyle illense* (Ziegler, 1883) Vejnar, 1956. Although my description of *B. polymorphus* coincides with that of *B. markewitschi* by Kowal and differs from that of *B. polymor-*

Table VI
Digenea — invasion of *Esocidae* and *Percidae* in 1950 and 1951

Host	Year	<i>Rhipidocotyle illense</i>					<i>Bunodera luciopercae</i>					caetera				
		Invasion	%	No. of parasites	Intensity	Index of invasion	Invasion	%	No. of parasites	Intensity	Index of invasion	Invasion	%	No. of parasites	Intensity	Index of invasion
<i>Esox lucius</i> L.	1950	29	28	97.0	10063	359	4	13.7	16	2—7	4	2	7	7	2-5	3.7
	1951	34	26	76.5	16029	625						2	9	3	1-2	1.5
<i>Perca fluviatilis</i> L.	1950	44	9	20.4	719	80	22	50	679	1—320	30.8					
	1951	14	3	21.4	79	26	7	50	135	1—100	19.2	1		1		1
<i>Lucioperca lucioperca</i> (L.)	1950	6					3		24	2—15	8	4	66.5	53		13.3
	1951	2					1		5	5	5	2		37		18.5
<i>Acerina cernua</i> (L.)	1950	21	1	4.75			3	14.2	4	1—2	1.3					
	1951	2														

Moreover in *Esox lucius* found once *Phyllodistomum folium*
once *Allocreadium isoporum*
and few *Bucephalus polymorphus*

Table VIa
Digenea — invasion of Cyprinidae and *Misgurnus fossilis* (L.)

Host	Year	No. of fishes examined	<i>Sphaerostomum</i> sp. sp.					<i>Asymphyiodora</i> sp. sp.					caetera				
			Invaded	%	No. of parasites	Intensity	Index of invasion	Invaded	%	No. of parasites	Intensity	Index of invasion	Invaded	%	No. of parasites	Intensity	Index of invasion
<i>Scardinius erythrophthalmus</i> L.	1950	17	1	0.6	1	1	1	2	10.2	4		2					
	1951	5						2	9.1	4		2					
<i>Tinca tinca</i> (L.)	1950	16						11	68.7	730	2—200	66.3	12	75.0	numerosus		
	1951	12						8	66.6	486	1—200	60.7	2	16.6	numerosus		
<i>Abramis brama</i> (L.)	1950	26															
	1951	23	1	4.3	7	7	7										
	1953	30	21	70	103	1—20	4.5										
<i>Blicca bjoerkna</i> (L.)	1950	19															
	1951	9															
	1955	10	9	90	87	1—17	9.7										
<i>Carassius carassius</i> (L.)	1950	10															
	1951	6															
<i>Misgurnus fossilis</i> (L.)	1950																
	1951	2	1		1	1	1						1	16.7	7	7	7

phus by Eckmann as regards the size and position of the vitellaria, this seems to me no adequate reason for creating a new species, particularly because Eckmann had only a few specimens of the parasite at her disposal. The question whether *B. markewitschi* is an independent species or a synonym of *B. polymorphus* will be decided by an investigator who will have more material from Germany at his disposal. Personally, I doubt whether in the same host may occur only *B. markewitschi* in the Soviet Union and Poland and only *B. polymorphus* in Germany. It seems to me that *B. markewitschi* is a synonym of *B. polymorphus* and that only two species of *Bucephalidae*: *B. polymorphus* and *Rh. illense* have so far been found in Europe's inland waters.

A description of both species from my own observation is given below.

Bucephalus polymorphus Baer, 1827

Syn.: *Gasterostomum fimbriatum* Siebold, 1848; *Bucephalus markewitschi* Kowal, 1949.

Body narrow, elongate, slightly tapering towards the end, bluntly cut in front, 1.2—2.2 mm long, furnished at the anterior end with a strongly muscled and contractile sucker of which the posterior part is cut bluntly, and the anterior mildly rounded, its continually changing size amounting to 0.127—0.269 by 0.113—0.225 mm. Cuticle covered with small spines, their number decreasing towards the end (Fig. 1a).

There are seven tentacles on the upper edge of the posterior part of the sucker, three lying dorsally, two laterally and two sub-ventrally. They are transparent tubes staining with eozine, wider at the base and narrower at the top. They may extrude and withdraw, turn inside out and outside in like fingers in a glove. Each of them has a branch at the base which may come out or disappear as does the main trunk of the tentacle. I failed to detect in the live and preserved materials another branch drawn by Woodhead for *Bucephalus elegans* and by Nagathy for *B. polymorphus*.

Tentacles appear singly or several at a time, seldom all of them at once. Among my 78 preparations of *B. polymorphus* there is not a single one quite without tentacles, but there are only two with a full number of them. The length of the tentacles amounts to 0.048—0.086 mm.

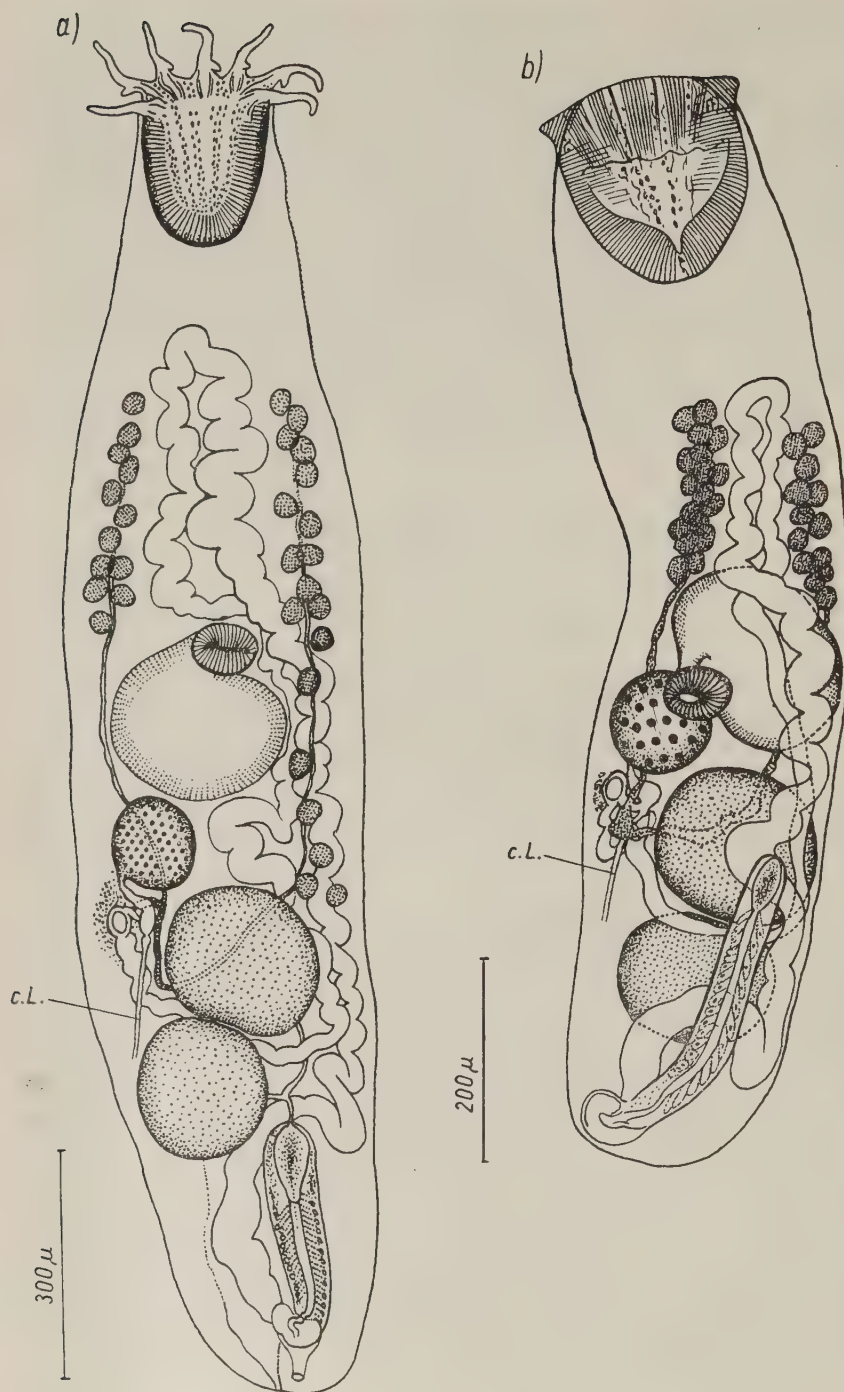


Fig. 1. a. *Bucephalus polymorphus*; b. *Rhipidocotyle illense* (Ziegler, 1883) Vejnár, 1956; ventral view. c. L. — Laurer's canal.

Alimentary tract. Oral opening on the ventral side, usually somewhat in front of the middle of the body going fairly deep inside like a narrow canal and joining a large, strongly muscled pharynx of a diameter varying from 0.040 to 0.096 mm. Pharynx passing in turn into a short, not always clearly visible oesophagus and the latter into a blind sacciform intestine the blind end of which is directed towards the dorsum and the posterior of the body.

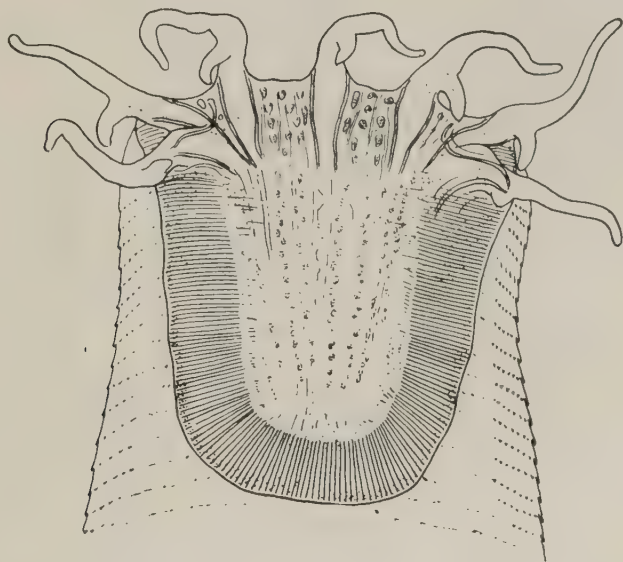


Fig. 2. *Bucephalus polymorphus*, anterior end; ventral view.

Male sexual organs. Testes lying in the posterior half of the body, left from the ovary, usually one before the other. They are almost spherical, the anterior somewhat larger than the posterior, their diameters amounting to 0.153—0.224 mm and 0.112—0.198 mm respectively. A vas efferens runs from either combining into a common vas deferens, which in turn passes into a seminal vesicle.

Cirrus sac very large, measuring from 0.204 to 0.356 mm, and lying on the left side of the body in its posterior part behind the testes. It covers the seminal vesicle, prostatic part and ejaculatory duct. The size of the seminal vesicle depends on the amount of semen in it. The prostatic part is long and wide, surrounded with numerous prostatic cells. The ejaculatory duct empties into the

genital sinus opening on to the ventral side near the end of the body (Fig. 1).

Female sexual organs. Ovary almost spherical, smaller than the testes, lying in front of the anterior testis on the right side, roughly half through the length of the body, 0.102 to 0.153 mm

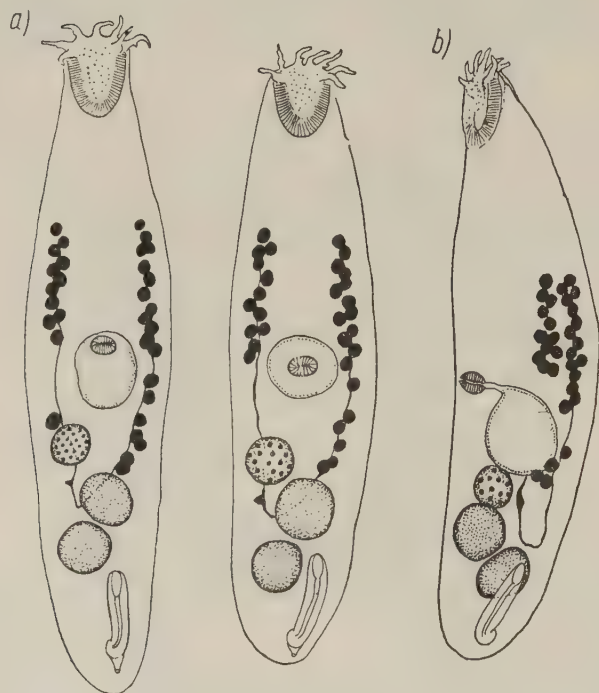


Fig. 3. *Bucephalus polymorphus*, outline topography of reproductive organs and alimentary tract. a — ventral view b — lateral view.

in diameter. Oviduct thin at first, widening at a small distance from the ovary. Laurer's canal runs from it and it is joined by a common vitelline duct. Its farther section forms an ootype surrounded by Mehlis's cells and passing into the uterus. The latter forms a few convolutions near the ootype, runs forwards and then backwards in convolutions to empty, as the male genital pore does, into the genital sinus. Its anterior convolutions do not go behind or go a little way behind the anterior limit of the vitellaria. Eggs 0.03 by 0.015—0.017 mm.

Vitellaria consisting of two longitudinal rows situated on both sides, varying in length. Right-hand row consisting of a group of 10

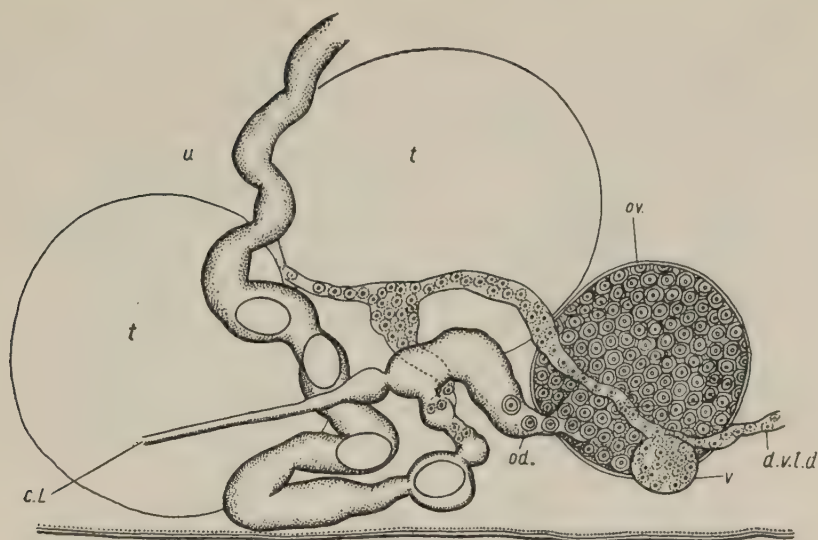


Fig. 4. *Bucephalus polymorphus*, female central reprod. system, ov. — ovary; od. — oviduct; c. L. — Laurer's canal; u. — uterus; d.v.l.d. — right-hand longitudinal vitelline duct; t. — testes.

to 12 follicles lying in the anterior half of the body and of one lying much farther right in front of the ovary and not always easy to detect. Left-hand vitelline gland considerably longer than the right-hand, yet terminating at the level of the anterior testis, i.e. already in the posterior half of the body. Vitelline ducts running irregularly. Right-hand branch shorter and running from the chief receptacle forwards at first, dorsally to the ovary; left-hand branch longer, running backwards at first, not crossing the limit of the anterior testis, suddenly swerving forwards then and running dorsally from the anterior testis forwards on to the left-hand side. Vitelline follicles fairly large, their diameter varying from 0.025 to 0.051 mm.

I succeeded in observing metacercariae of this species twice: once in the fins of *Blicca* at Lake Družno in 1955 and again in the muscles of Cyprinid fry at Mamry Pólnocne in 1956. Their cysts were almost spherical and measured from 0.274 to 0.365 by 0.438 mm. A dark S-shaped excretory vesicle could be seen through a transparent screen in all larvae and so were long and transparent tentacles in some (Fig. 5).

When removed from the screens, larvae began quickly to stretch and contract, extrude and withdraw alternately their long trans-

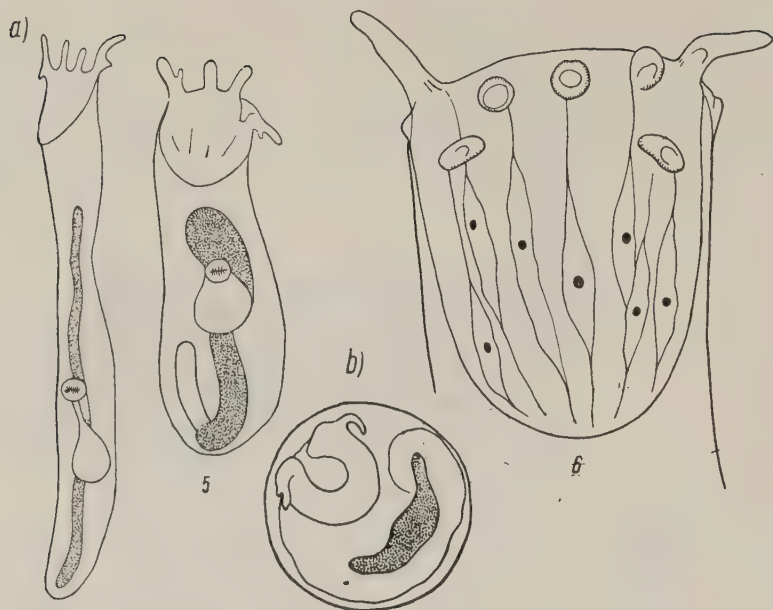


Fig. 5. *Bucephalus polymorphus*, metacercariae from gills of *Blicca björkna*. a — removed from cyst; b — in cyst. Fig. 6. *Bucephalus polymorphus*, metacercaria, anterior end.

parent finger-like tentacles. Some of the larvae were still very young. Their internal organs were still underdeveloped and their suckers quite transparent. Among the muscles of the latter which were only beginning to form seven coiled tentacles could be observed not far from the front edge. Two of them lay dorsally, two at sides, two subventrally. From time to time some of them disappeared entirely or partially, turned inside out or just as rapidly withdrew into the sucker.

The above description of *B. polymorphus* coincides with Kowal's description of *B. markewitschi* (1949), but differs somewhat from Eckmann's description of *B. polymorphus* Baer, 1827. According to Eckmann *B. polymorphus* has only 6 tentacles, vitellaria equal in length and limited to the anterior part of the body, and 10 to 12 vitelline follicles on either side. Nagathy's description of *B. polymorphus* from the Black Sea differs from mine in that its measurements vary more widely. More essential is the difference in the range of the vitellaria and the position of the pharynx. According to Nagathy the vitellaria are confined to the anterior part of the body and their num-

ber varies from 9 to 24 and the pharynx is situated in the middle or behind the intestine, while in Kowal's and my descriptions the left-hand vitellarium descends considerably farther backwards from the middle of the body and the number of vitelline vesicles (not stated accurately by Kowal) amounts in my material to 12—13 in the right-hand vitellarium and to 16—19 in the left-hand. As stressed by Kowal the pharynx in *B. markewitschi* lies either in the middle or towards the front of the intestine.

Rhipidocotyle illense (Ziegler, 1883) Vejnar, 1956

Syn.: *Distoma campanula* Duj., 1843; *Gasterostomum fimbriatum* s. Ziegler, 1883; *Bucephalus polymorphus* s. Lühe, 1909; *B. polymorphus* s. Kowal, 1949.

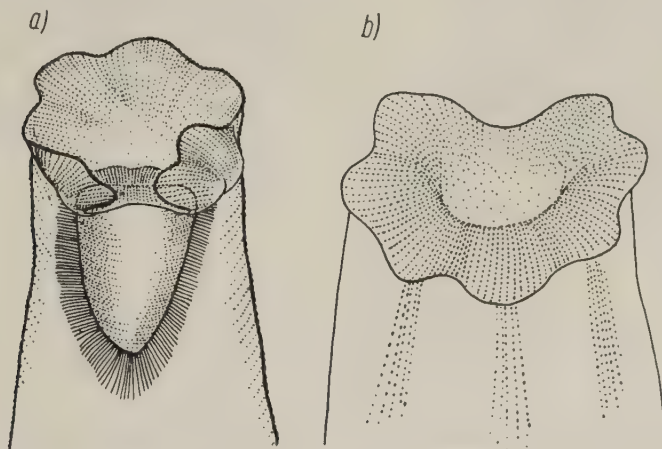


Fig. 7. *Rhipidocotyle illense* (Ziegler, 1883) Vejnar, 1956. a — anterior end viewed from the ventral side, with collar spread fan-wise; b — viewed from the dorsal side with collar down.

Body elongate, covered with small spines, narrow, slender, rounded and tapering towards the end, bluntly cut at the front, measuring $0.840\text{--}1.080 \times 0.16\text{--}0.28$ mm (Fig. 1 b). It possesses a sucker at its anterior end which opens on the ventral side and differs from the sucker of *B. polymorphus* in that it has no tentacles. Its size varies from $0.178\text{--}0.229 \times 0.15\text{--}0.214$ mm, and the length to width relation varies continuously depending on the high contractility of the organ. Above the upper edge of the posterior part of the sucker there is a „cowl” with seven muscular stripes which can spread over the sucker as a fan with seven fingers; it is diffi-

cult to count the fingers of the fan. I succeeded to observe a spread fan only in fully adult specimens filled with eggs. It is usually invisible and the parasite may in that case be assigned to the genus *Rhipidocotyle* only on the basis of the presence of a muscular cylinder surrounding the dorsal part of the posterior portion of the sucker and resembling a crest sticking out upwards (Fig. 10 b). What can be observed most often are two stoff horns sticking out side-

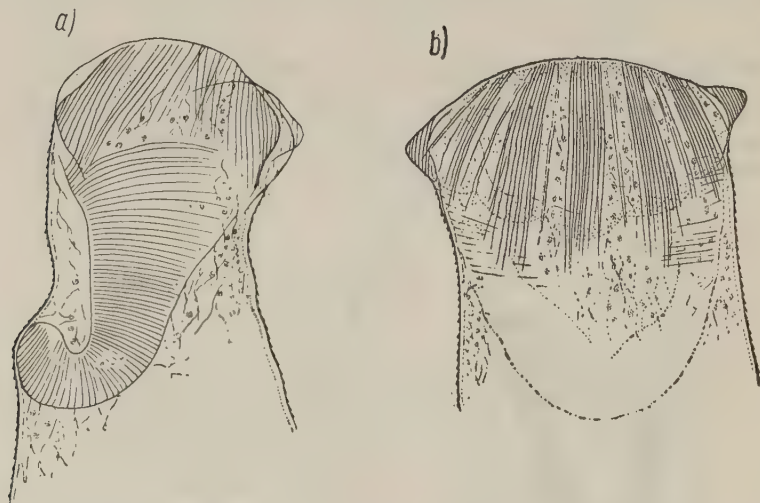


Fig. 8. *Rhipidocotyle illense* (Ziegler, 1883) Vejnár, 1956, arrangement of muscular fibres of anterior end, a — lateral view; b — dorsal view.

ways and described already by Lühe (1909) and Dogiel (1932); the muscles running parallel to their base and to the length of the body itself in them (Figs. 8 and 10).

Alimentary tract. Oral opening usually situated backwards from the middle of the body, going fairly deep inside like a narrow and thin canal, passing into a strongly muscled pharynx measuring 0.051—0.061 mm, communicating through a short oesophagus with a sacciform, blindly terminated intestine directed towards the dorsum and the front of the body which reaches the posterior limit of the ovary (Fig. 9).

Sexual organs. Two testes situated one behind the other, sometimes obliquely to each other, in the posterior part of the body. The anterior is larger (0.096—0.137 mm in diameter) than the posterior (0.076—0.137 mm). A vas afferens runs from either and combines with the other into a somewhat larger vas deferens

which passes in turn into the seminal vesicle. Cirrus sac lying in the posterior part of the body, within the reach of the testes, measuring 0.178—0.285 mm, sometimes up to 0.300 mm $\times$ 0.035—0.071 mm, thick, powerful and often slightly bent. It contains a seminal vesicle, a long prostatic part surrounded with prostatic cells and an ejaculatory duct emptying directly into the genital sinus situated

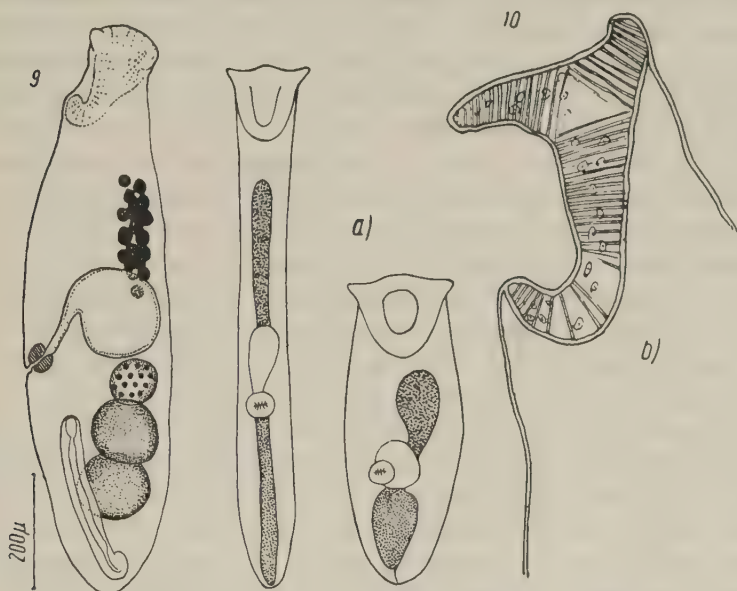


Fig. 9. *Rhipidocotyle illense* (Ziegler, 1883) Vejnár, 1956, outline topography of reprod. organs and alimentary tract, lateral view. Fig. 10. *Rhipidocotyle illense* (Ziegler, 1883) Vejnár, 1956, metacercariae from cysts in gills of *Abramis brama*, and a longitudinal section of anterior end of *Rh. illense* metacercaria.

on the ventral side close to the end of the body. Ovary almost spherical, smaller than the testes, 0.076—0.102 mm in diameter, lying in front of the testes somewhat on the right, about half way through the length of the body. Oviduct thin at first, issuing Laurer's canal and receiving the vitelline duct, and changing into an ootype first and an uterus then. Uterus running towards the front first, not usually crossing the anterior limit of the vitellaria, returning backwards also in convolutions and emptying, like the ejaculatory duct, into the genital sinus. Vitellaria lying in two fairly compact groups on the sides in the second fourth of the body. The number of follicles varies from 11 to 16 in group. Follicles so-

mewhat smaller than in *B. polymorphus*, 0.025—0.030 mm in diameter. Vitelline ducts meeting, combining into an arch between the front testis and the ovary.

Excretory bladder in the shape of a straight sac, starting close to the sucker and reaching the posterior end of the body.

Cysts of the metacercariae of this species (0.27×0.27 — 0.51×0.37 mm) are spherical or oval. There are one or several metacercariae inside a cyst. In the latter case each metacercaria is separated from its neighbour by a thin wall. The cysts are so transparent that the fluke body and the S-shaped excretory bladder darker than the fluke show through them.

When removed from their cysts, metacercariae move quickly, contract and extend alternately, two lateral processes appearing on the sides of the sucker as described by L ü h e (1909).

Metacercariae are usually to be found on the caudal, dorsal, pectoral, and ventral fins, on the gills and muscles (usually at the base of the tail), in the eyes, brain and the subcutaneous tissue in all fish species. They occurred heavily in some fish species at Družno and were very common in fry, too.

The description of *Rh. illense* given by L ü h e (1909), that given by K o w a l (1949) of *B. polymorphus* and that by V e j n a r (1956) all coincide with mine.

Very similar to *Rh. illense* is *Rh. septapapillata* K r u l l, found in *Lepomys gibbosus* from the river Potomac near Alexandria, USA in 1934. That fluke resembles *Rh. illense* in the shape of the body, the character of the „cowl” widening as a fan, and the topography of the internal organs. The main difference between them is that they occur in different hosts at all stages of circulation in the biocoenosis. *Anodonta mutabilis* is according to Ziegler (1883) the first host of the cercaria of *Rh. illense*, while *Lampsilis siliquoides* of the family *Unionidae* is the host of the cercaria of *Rh. septapapillata* (*Cercaria basi* W o o d h e a d, 1926) in the same stage. *Cercaria basi* differs from the cercaria of *Rh. illense* in external form.

Almost all species of fresh-water fishes are hosts of the metacercaria of *Rh. illense*, while according to K n i s k e r n (1956) *Lepomys gibbosus*, *Micropterus dolomieu* and *Lebistes* are hosts of *Rh. septapapillata*. Finally, in the third stage the main hosts of the definite form of *Rh. illense* are *Esox*, *Lucioperca*, *Silurus*, and *Anguilla*, while the main hosts of *Rh. septapapillata* are *Micropterus salmoides* and (K n i s k e r n, 1956) *Lepomys gibbosus*. On the

other hand, attempts failed experimentally to obtain the definite form in *Esox*, which is the principal host of *Rh. illense* in Europe, or in *Perca*. Neither was the definite form of *Rh. septapapillata* encountered in the natural conditions of the river Huron (K n i s k e r n, 1956).

The question arises therefore whether *Rh. illense* and *Rh. septapapillata* should be regarded as identical or different species. The anatomical similarity witnesses in favour of the former view, and the divergency of biological features in favour of the latter.

In my opinion the establishment by evolution of such irreversible features as the incapability to occur in the same hosts suggests that the species are different.

I failed to establish the periodical occurrence of definite forms of *B. polymorphus* and *Rh. illense*. I used to find fully adult specimens of *B. polymorphus* filled with eggs in June, July, and August, and the definite form of *Rh. illense* from April to November (there being no reasearch conducted in the winter months). I first discovered single specimens of this fluke which were only in the first stage of maturity in June. I came across a large number of adult specimens filled up with eggs several times in July and August. It is noteworthy that specimens not quite mature sexually used to be in majority.

It is difficult to determine the distribution of *B. polymorphus* and *Rh. illense* as these species were mistaken for one. *B. polymorphus* was found in Germany, the Soviet Union (Dnieper), Czechoslovakia (V e j n a r), and Poland (Vistula, Družno, Mamry Pólnocne). A species very similar to *B. polymorphus* was described under this name also by N a g a t h y in the Red Sea. *Rh. illense* seems to be more common than species of the genus *Bucephalus*. It was found in Germany and is very common in the Soviet Union and Poland.

Lucioperca is the main host of the definite form of *B. polymorphus*. I found it in an incomparably smaller number in *Esox* at Družno. On the other hand, *Esox*, in which it occurs heavilly is the main host of *Rh. illense*. I found it in a considerably smaller number in *Perca* and *Acerina* and it used to be observed in *Anguilla*, *Silurus*, and others (M a r k e w i t s c h, 1951).

I distinguished metacercariae of *B. polymorphus* once only, while 11 fish species were invaded by metacercariae of *Rhipidocotyle* at Družno.

The species in which metacercariae settled heavily in the fins, viz., above all *Abramis*, then *Blicca*, *Rutilus*, and in a far smaller

degree *Scardinius*, proved to be the main hosts of *Rh. illense* (Table VI).

Table VII

Metacercariae of *Rhipidocotyle illense* (Ziegler) —invasion of adult fishes in 1950 — 1951

Host	Year	No. of fishes examined	Invaded	%	Index of invasion	No. of parasites
<i>Esox lucius</i> L.	1950	29	5	17.2	7.8	39
	1951	34	3	8.3	2.0	6
<i>Abramis brama</i> (L.)	1950	26	23	88.5	32.2	7404
	1951	23	18	78.3	27.6	4996
<i>Rutilus rutilus</i> (L.)	1950	27	19	70.5	82.0	1552
	1951	23	15	65.3	33.8	508
<i>Blicca björkna</i> (L.)	1950	19	10	52.6	70.3	703
	1951	9	8	89.0	193.0	1547
<i>Sc. erythrophthalmus</i> (L.)	1950	17	6	35.3	40.5	243
	1951	5	3		46.4	139
<i>Carassius carassius</i> (L.)	1950	10	5	50.0	4.8	24
	1951	6				
<i>Gobio gobio</i> (L.)	1950	5	1		1.0	1
	1951	5	4		145.0	582
<i>Alburnus alburnus</i> (L.)	1950	4	2		17.5	35
	1951	1	1		14.0	14
<i>Perca fluviatilis</i> (L.)	1950	44				
	1951	14	2	14.0	1.5	3
<i>Lucioperca lucioperca</i> (L.)	1950	6	1		4.0	4
	1951	2				
<i>Acerina cernua</i> (L.)	1950	21	1	4.8	1.0	1
	1951	2	1		2.0	2

It follows from the data shown in that table that as both the number of species invaded and the invasion percentage and intensity are high, *Rh. illense* should be regarded as an element numerically dominant in the biocoenosis of Lake Družno.

Allocreadium isoporum (Looss, 1894)

As the anatomical structure of the parasites I found does not as a rule differ from Looss's description, I do not repeat that description and only add a few small particulars concerning the great contractility of *Allocreadium*. In some of my preparations, the uterus, which according to Looss covers the space between the ventral sucker and the anterior testis, reaches as far as behind the hind edge of the testis. The range of the vitellaria also varies, as they terminate as a rule at the level of the ventral sucker and sometimes reach almost its posterior limit (Fig. 11).

The distribution of *Allocreadium isoporum* covers Western Europe and the USSR (Markewitsch, 1951). The fluke is very common in the Soviet Union, where it was discovered in the basins of the Baltic, Black, and Azov Seas, in Lake Baikal, in the rivers Ob, Irtysh and Lena.

Its hosts are chiefly *Cyprinidae* and sometimes it is found in *Esox* as well (Markewitsch, 1951; Looss, 1894).

As regards the previous Polish authors, Kowalewski (1895, Dublany) was the first to observe *A. isoporum* in *Cyprinus*, and much later Milicer (1938) observed it in *Scardinius* and *Carassius* at Lake Wigry. I found it in *Carassius* and *Esox* at Družno, in *Carassius* at Lake Łabędzie, and in *Scardinius*, *Gobio* and *Alburnus* at Mamry Północne.

In the intestine of its hosts, *A. isoporum* occurs either by itself or with other parasites specific to a given fish species. I found it together with *Camallanus lacustris*, *Rhipidocotyle illense*, and *Acanthocephalus lucii* in *Esox*, by itself in *Carassius* at Družno, and very often together with *Asymphylogodora markewitschi* in *Scardinius* at Mamry.

I failed to observe a distinctly periodical occurrence of *A. isoporum*. All I can say is that I met it in the summer months. I found it at Lakes Družno and Łabędzie in July, at Mamry Północne, where it is very common, in July, August, and even in September, while Kowal (1949) points out that as early as August she could no find it in the Dnieper.

In view of the very small invasion intensity and extensity (I discovered seven specimens in *Carassius* on one occasion at Družno) *A. isoporum* may be regarded as non-characteristic of the biocenosis of Družno.

Bunodera luciopercae (O. F. Müller, 1776)

The first good description of the parasite came from Looss (1894), the second from Hopkins (1934), who added a number of details ignored by Looss and a different description of the excretory bladder.

I supplement the description of *B. luciopercae* with one detail: although according to Looss' and Hopkins's descriptions both suckers are almost equal, the ventral sucker was usually smaller than the oral in my preparations. Moreover, of the six processes at the oral sucker the two ventral ones seem to be more strongly muscled than the lateral and dorsal ones. Eggs, up to 0.1 mm long according to Looss, were 0.085—0.096 mm long in my material.

The distribution of *B. luciopercae* covers Western Europe and the USSR as well as North America. In the USSR the fluke was found in the waters of the basins of the White, Black, Azov, and Caspian Seas, and in the Siberian rivers.

The main hosts of *B. luciopercae* are the predatory fishes *Perca*, *Lucioperca*, *Esox*, *Salmo*, *Silurus*, *Acerina*, and others. Of the Polish authors, Sinicyn (1905) found this fluke in *Lucioperca* near Warsaw, and so did Ruszkowski in *Perca* and *Esox* in 1925, Dąbrowska in *Lucioperca*, *Perca* and *Acerina* in the Vistula in 1926, and Milicer (1938) in *Perca* and *Esox* from Lake Wigry. I found it in *Perca*, *Lucioperca*, *Esox* and *Acerina* at Lake Družno, and in *Perca* at Lakes Gołdapiwo and Mamry Północne.

At Družno I observed quite a distinctly periodical occurrence of *B. lucioperca* of which certain mentions may be found already in Ruszkowski (1925) and Milicer (1938), and which Lajman (1940) treated in detail and on the evidence of a large material.

The first parasites in the intestine of the host occur only early in August, exceptionally in the last decade of July. The intensity of invasion can best be seen in *Perca*, which was invaded more strongly and of which I examined more than of other species, rises in September and October. In accordance with Lajman's findings I observed no eggs in the fluke in that period. True I did not find any as late as October either, but this was probably due to the small number of *Perca* examined in that period. No investi-

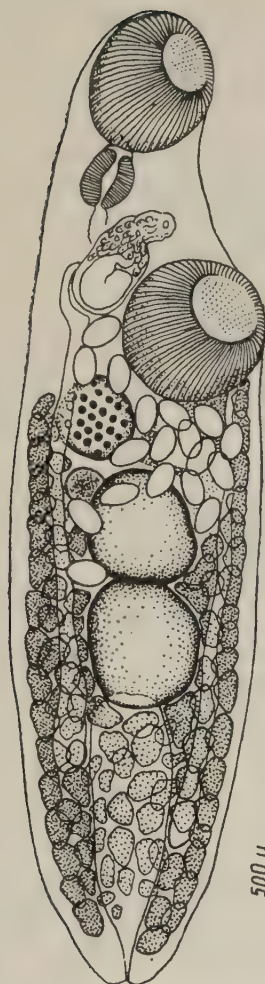


Fig. 11. *Allocreadium isoporum* Looss, 1900 from intestine of *Carassius carassius*.



Fig. 12. *Bunodera lucio-percae* (O. F. Müller, 1776) from intestine of *Perca fluviatilis*.

gations were made in December and January. In the *Perca* I was sent in mid February most *Bunodera* had many eggs, fewer had few of them, and some had no eggs yet. On the other hand, in the *Perca* examined at the lake in mid March, invasion amounted to 100%, intensity varying from 37 to 246 and all flukes being already over-filled with dark-brown eggs. In May I still found either a small or even a considerable number of parasites. They were

heavy, immobile and full of eggs. No investigations were made at Družno in June, but I could find not a single *Bunodera* in *Lucioperca* and *Perca* from Vistula Bay which I examined in June. Parasites first appeared late in July and more frequently from August onwards.

At Lake Družno *B. luciopercae* occurred either by itself or together with other intestinal parasites such as *Bucephalus polymorphus*, and *Rhipidocotyle illense*, *Camallanus lacustris* and *Acanthocephalus lucii* in *Perca*, *Esox*, *Lucioperca* and *Acerina*. I found it twice in *Perca* together with very young *Proteocephalus* sp.

The occurrence in four host species and the high invasion percentage of the main host, *Perca*, in February and March make it possible to assign *Bunodera luciopercae* to the parasites characteristic of Družno.

Genus *Sphaerostomum* (Rud., 1802) Stiles et Hassal, 1898

The name of *Sphaerostomum* comes from Rudolphi, who assigned to this genus all flukes with large strong suckers. Stiles and Hassal were first to assign the name of *Sphaerostoma* to a definite species: *Distomum globiporum* (Rud., 1802) Looss, 1894.

In 1899 Lühe changed the name of *Sphaerostomum globiporum* (Rud., 1802) to *Sphaerostomum bramae* (Müller, 1776), probably on the basis of priority, and the name of *S. globiporum* fell to the synonym, while *S. bramae* became the only representative of the genus. This was later accepted by Dawes (1946) as well as Skrjabin (1948) and Markewitsch (1951).

In 1944 Szidat compared a great number of *S. bramae* from various hosts and came to a conclusion that *S. bramae* and *S. globiporum* are no synonyms, and that both *S. bramae* and *S. globiporum* are collective units.

On the basis of specificity to various hosts and the range of the uterus it is possible — according to Szidat — to distinguish both the above mentioned species in the descriptions by previous investigators. Müller, Burmeister and Siebold dealt, according to him, with *S. bramae*, and Rudolphi with *S. globiporum*. The first right description of the anatomical structure and development of *S. globiporum* came from Looss in 1894, who still called it *Distomum globiporum* (Rud., 1802).

In addition to the two above mentioned species Szidat also described another — *Sphaerostomum minor* Szidat in *Idus me-*

lanotus (L.), and believed there might exist a fourth. That fourth species was discovered and described by Janiszewska (1948) under the name of *Sphaerostomum maius*.

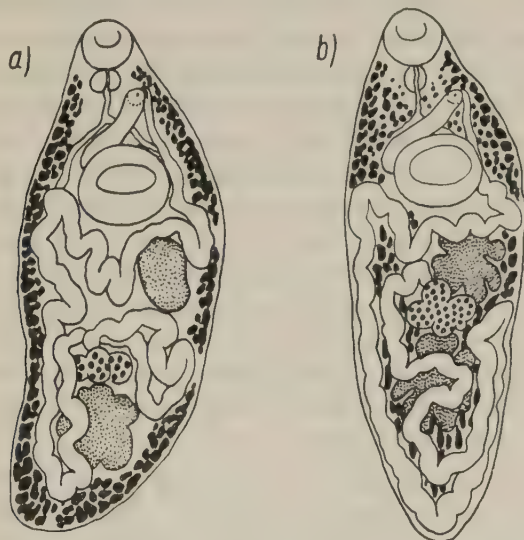


Fig. 13. Mutual relation of positions of uterus and vitellaria in: a — *Sphaerostomum globiporum*, b — *S. bramae*.

At my disposal there are only *S. globiporum* and *S. bramae*, species which have not been distinguished by some authors so far.

Sphaerostomum globiporum (Rud., 1802) Szidat, 1944

Syn.: *Fasciola globipora* Rudolphi, 1802; *Distomum globiporum* (Rud.) Looss, 1894 in part.; *Sphaerostomum globiporum* (Rud.) Looss, 1899 in part.

S. globiporum (Fig. 15 c) has an elongate body tapering toward the ends. Its front part being very mobile may extend and contract to a large extent. The length of the fluke amounts to 2.0—2.92 mm by 0.5—0.730 mm.

Suckers large and well-muscled, the oral always smaller than the ventral. In my preparations the size of the oral sucker situated subterminally varies from 0.21—0.22 by 0.208—0.231 mm.

Ventral sucker lying usually before the middle of the body; its diameter amounting to 0.277—0.308 by 0.308—0.346 mm.

The mutual relation of both suckers is usually 1 : 1.5.

Alimentary tract. Oral opening at the front of the body; pharynx large and well-muscled; oesophagus fairly large and long,

bifurcating about half way between the suckers; intestines descending far backwards, almost to the end of the body.

Testes lying in the posterior part of the body behind the ventral sucker; the anterior more on the left, the posterior more or less obliquely to it, closer to the middle; the anterior is usually spherical or oval, with edges almost even, sometimes slightly indented; the posterior usually somewhat larger, more lobar and shapeless, lying in mature specimens most frequently very far backwards without however overlapping too much the vitellaria meeting at, and filling up the end of the body; both testes becoming shapeless, large and diffuse as it were in very old specimens.

Cirrus sac well-muscled and large, lying almost all in front of the ventral sucker. Its posterior portion, thick and wide tapering towards the middle and passing at the end into a thick, wide and powerful cirrus which, like a mace, may extrude somewhat outside. A very slight convexity of the ejaculatory duct may be observed in it. Seminal vesicle single.

Vitellaria running in two lateral rows along the sides of the body. Depending on contractions they reach the level of the pharynx or even of the oral sucker. They are thicker between the oral and ventral suckers but do not overlap the oesophagus or the pharynx. They meet behind and fill up the posterior end of the body behind the posterior testis. This peripheral arrangement of the vitellaria characterizes both young and adult specimens.

Ovary small in comparison to the size of the testes, with deep indentures, four-lobed, lying always between the testes. In young specimens, the ovary and the testes lie near each other in the middle part of the body; they shift backwards in mature specimens. Eggs 0.080—0.087 by 0.043—0.050 mm.

Uterus very entangled, growing large in the space limited in front by the ventral sucker and by the lateral and posterior sections of the vitellaria on the sides and at the back. The lateral sections of the vitellaria usually crossing only the extremities of two transverse convolutions of the uterus of which one lies behind the ventral sucker and the other behind the anterior testis. The pressure from them brings about the degeneration of a certain number of vitelline follicles and gaps in their lateral rows of which there are usually none in young specimens.

The loop, situated behind the anterior testis thrusts the ovary with the posterior testis backwards as it fills up with eggs. The

anterior testis situated between two convolutions full of eggs remains in its place.

Uterus descending backwards, surrounding the posterior testis in front, and going down along its right side not only as far as the middle, as given by Looss (1894) and Szidat (1944), but also behind its posterior edge, and returning forwards from there on the right side of the body without filling up the space taken up by the posterior sections of the vitellaria. It turns to the left behind the ventral sucker, goes on along the left side of the ventral sucker, changes into a metraterm, thick and wide and equal to the cirrus sac in length and exits near the male genital pore on the left side of the body.

As essential features of *S. globiporum* the following should be mentioned: intravitellar arrangement of uterus, peripheral position of vitellaria, posterior end of body free from eggs and filled up with vitelline follicles, posterior position of second testis and ovary, single seminal vesicle, almost smooth anterior testis and poorly indented posterior testis, ovary large-lobed and fairly large in relation to testes, oral to ventral sucker relation 1 : 1.5, caeca reaching almost as far as the end of body.

As most important of these the following should be regarded: arrangement of uterine tube, posterior position of second testis and vitellaria, structure of male external genital ducts and arrangement and position of vitellaria (Fig. 13).

S. globiporum can be distinguished from *S. bramae* or *S. maius* at the first sight by the posterior end of the body being free from eggs and filled up with vitelline follicles and by the peripheral position of the vitellaria.

Rutilus and *Scardinius* are main hosts of this species. I found it in *Scardinius* and *Misgurnus* at Družno.

Sphaerostomum bramae (Müller, 1776) Szidat, 1944

Syn.: *Fasciola bramae* Müller, 1776; *Sphaerostomum bramae* (Müller, 1776) Lühe in part.

The arrangement and structure of the suckers, alimentary tract, excretory bladder and reproductive organs in this species also coincide with the features of the genus *Sphaerostomum* (Stiles et Hassal, 1898). In the general appearance of the body *S. bramae* resembles *S. globiporum* (Fig. 14 and 15), while it differs from it quite distinctly in generic features, and more so than from *Sphaerostomum maius* Janiszewska, 1948 (Fig. 15 a, b & c).

The body size of the adult specimens I sampled amounted to 1.433 to 2.158 mm, and to 3.1 mm in an extreme case. Diameter of oral sucker 0.154×0.183 —0.223 mm. Oral to ventral sucker relation 1 : 1.53—1 : 1.64. The difference between the oral and ventral suckers in this species may be even larger and coincides with Szidat's figures (1944). The comparatively small difference in the size of the suckers in my material should be regarded as due to my specimens of *S. bramae* having been preserved without the pressure from the cover glass.

The testes of *S. bramae* are usually more lobar than those of *S. globiporum*. Its ovary is somewhat smaller in relation to the testes and not so deeply indented as that of *S. globiporum* and consequently its lobes are even smaller. Yet the size, shape and depth of indentures of the reproductive organs are features which vary within certain limits in both species depending on the age and it is impossible to base on them distinctions between both species.

Cirrus sac short and thick, terminated with a wide and well-muscled cirrus. Seminal vesicle double, in contradistinction from *S. globiporum* (Fig. 15 b & c).

The vitellaria of young specimens of *S. bramae* lie, just as they do in young specimens of *S. globiporum*, peripherally in two lateral rows meeting at the back. They are wider than in *S. globiporum* in the anterior part so that some of the follicles usually cover the oesophagus and pharynx like a collar. Similarity in the arrangement of the vitellaria makes the young forms of both species resemble each other closely, as pointed out by Szidat in 1944. But while this arrangement remains peripheral in young and mature specimens of *S. globiporum*, it becomes central in mature specimens of *S. bramae*. Accordingly, the essential features distinguishing both species from each other are distinct only in mature specimens. These features seem to develop among other things depending on the arrangement and development of the uterine tube, both different in both species. Except for its two transverse convolutions it grows in *S. globiporum* inwards from the lateral and posterior sections of the vitellaria, while in *S. bramae* it covers with its convolutions not only the gonads and caeca, but also the lateral rows of the vitellaria, and descends farther back than in *S. globiporum* to the very end of the body. Consequently the posterior vitelline follicles become degenerate and the uterus with the eggs contained

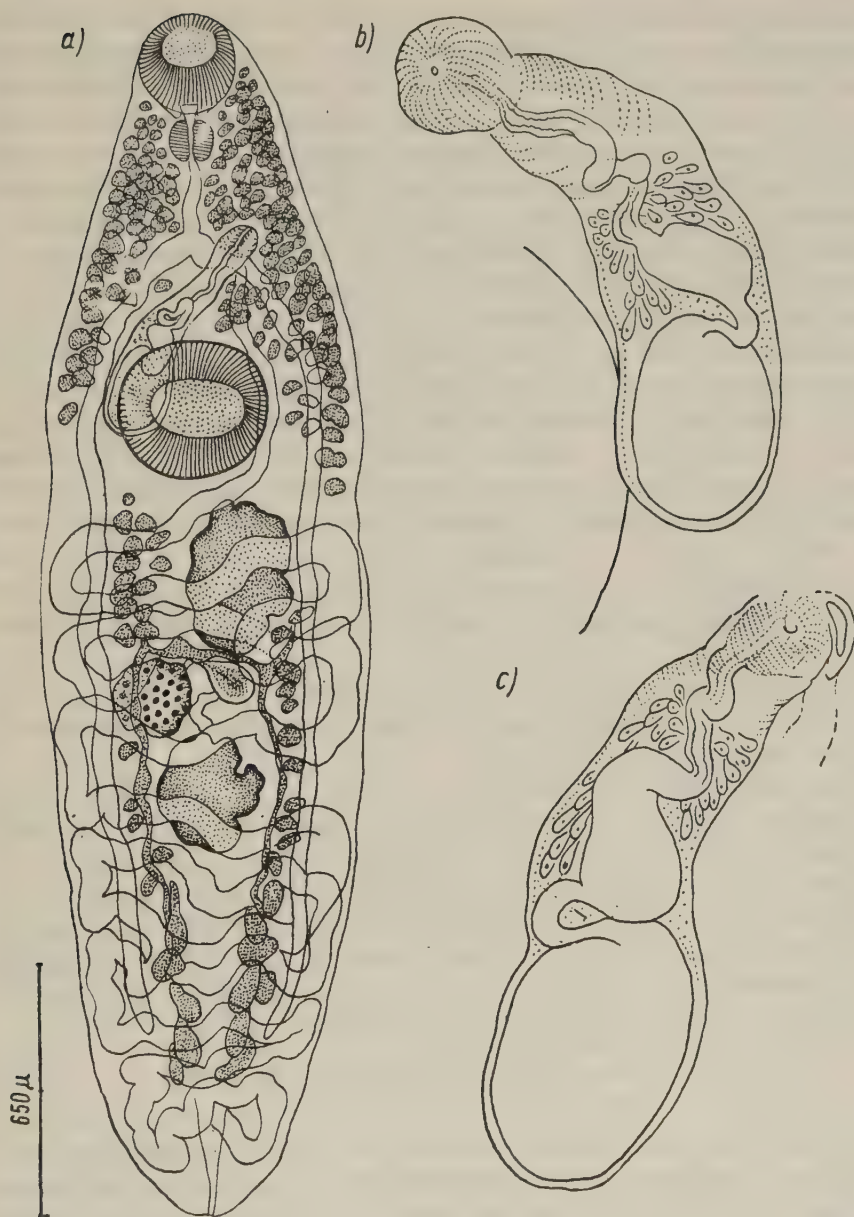


Fig. 14. *Sphaerostomum bramae*. a — specimen from *Abramis brama*;
b, c — cirrus sac.

in it fills up the posterior end of the body, which may be one of the reasons for which the posterior testis and ovary do not shift down as they do in *S. globiporum*. They lie at a certain distance from each other in the mid part of the body. On the other hand, the pressure from the uterus filling up with eggs causes first of all the degeneration of part of the lateral vitelline follicles and their replacement towards the middle of the body. In fully mature specimens of *S. bramae*, the vitellaria lie not peripherally but centrally. They hang in the middle of the body like large drops or grapes (Fig. 15 b). The following are the essential features of *S. bramae*: extra-vitellar arrangement of uterus; central position of vitellaria, proper only to fully mature specimens; degeneration of posterior sections of vitellaria and repletion by eggs of posterior end of body; wide anterior sections of vitellaria; bipartite seminal vesicle; vaguely lobar anterior testis and fairly deeply indented posterior testis; more anterior position of testes and ovary; oral to ventral sucker relation 1:1.53—1:1.64 and caeca reaching less backwards than in *S. globiporum*.

The repletion of the posterior end of the body by eggs and the central arrangement of the vitellaria help distinguish *S. bramae* at the first sight.

Blicca, *Abramis* and *Vimba* are main hosts of this species. I found it at Družno in *Abramis* and, two years later after the completion of the team research, in *Blicca*.

In addition to the above typical forms of *S. globiporum* and *S. bramae* from the intestine of adult fishes I found at Mamry Pólnocne in 1956 a form of *S. globiporum* which differed in many respects from the typical one which occurs in the intestine of the youngest (0+) Cyprinid fry (mostly *Rutilus* and *Scardinius*). I quote its description as it constitutes an interesting example of variability and pliability of the parasite and of the influence of the habitat of the first order on its internal organization:

Sphaerostomum globiporum (R u d., 1802)
non-typical form (Fig. 15 d & e)

The structure and arrangement of the suckers, alimentary tract, excretory bladder and reproductive glands coincide in the non-typical form of *S. globiporum* with the character of the genus *Sphaerostomum* (Stiles et Hassal, 1898) Looss, 1899. Body dimensions nearly half as small, varying from 0.940 to 1.651 mm. Oral sucker 0.128—0.172 × 0.052—0.197. Ventral sucker 0.157—0.202

by 0.169—0.231 mm. Anterior testis almost whole-edged, spherical or oval. Posterior vaguely lobar. Ovary four-lobed and smaller in proportion to smaller body dimensions. I have not examined the structure of the seminal vesicle. Cirrus sac mace-like and thick. Vitellaria running in two rows on the sides of the body between the oral sucker and the end with no gaps in the lateral rows, meeting at the back; their anterior sections, like those in *S. globiporum*, being not very wide.

Identical with the typical form is the peripheric arrangement of the vitellaria, their position in the posterior section of the body, the shape of the testes and ovary. Different from the typical form are a far wider range of the uterus and the repletion of the posterior section of the body by its convolutions and eggs, and the arrangement of both testes and the ovary more at the front.

What strikes at sight in the preparations is a peripheral arrangement of the vitellaria as in *S. globiporum* with the posterior end being filled up with eggs as in *S. bramae*.

The formation of the non-typical form may be accounted for by the checked growth of the body with the swift growth of the uterus stimulated perhaps by the increased production of eggs in the thermal conditions of the summer months. It seems to grow fast and reaches the very end. The repletion of the posterior section by eggs may prevent the posterior testis and ovary from shifting down. They most often remain, as they do in *S. bramae*, in the mid part of the body. The arrangement of the uterine convolutions in the mid section of the body, somewhat different than in the typical form of *S. globiporum*, may also play some part here, as witnessed by the absence of gaps in the lateral rows of the vitellaria.

The above features divergent from those encountered in the typical form do not last long. In spring I used to find only large old flukes up to 3 mm in length and coming probably from last-year invasions in *Rutilus* fry 3 cm long and starting the third year of life. They did not differ, except for the size, from typical *S. globiporum* from the intestine of adult fishes or two-year-old (1+ — 2+) *Rutilus* and *Scardinius* fry.

The fry form of *Sphaerostomum* witnesses to a great pliability of the species and is a transition between *S. globiporum* and *S. bramae* (arrangement of vitellaria and range of uterus). A hypothesis



Fig. 15. Representatives of the genus *Sphaerostomum*. a — *S. maius* Janiszewska, 1949 from intestine of *Squalius cephalus*; b — *S. bramae* (Müller, 1776) from intestine of *Blicca björkna* (L.) from Lake Družno; c — *S. globiporum* (Rud., 1802) Szidat from intestine of *Rutilus rutilus* (L.); d, e — non-typical form of *S. globiporum* from intestine of fry from Lake Mamry Północne.

could be ventured that *S. bramae* originated from *S. globiporum* by the extension of the uterus, which increased its range, thrust the vitellaria to the centre and causes them partly to degenerate.

The distribution of *S. bramae* and *S. globiporum* sensu Szidat was difficult to reproduce as both species were treated as one. The distribution of the collective species sensu lato, covers according to Dawes (1946), Skrjabin (1948) and Markewitsch (1951) Western Europe and the Soviet Union (the basins of the Baltic Sea, the Ob and the Irtysh, the Southern Bug, Dniester and Danube).

In Poland representatives of this species sensu Lühe were recorded by Sinicyn (1905) and Ruszkowski (1925) near Warsaw, by Dąbrowska (1926) in the Vistula near Warsaw and by Milicer (1938) in Lake Wigry.

According to Lühe (1909), Stiles et Hassal and Dawes (1946) numerous fish species, mostly Cyprinid, are hosts of *S. bramae* sensu Lühe. In Poland *S. bramae* sensu lato was recorded by Sinicyn in *Alburnus*, Ruszkowski, Milicer and Dąbrowska in *Rutilus* and *Scardinius*, and finally Dąbrowska (1926) in *Esox*, *Leuciscus*, *Aspius*, *Chondrostoma*, *Abramis*, *Blicca* and *Perca*.

S. globiporum was found in Germany by Szidat in *Rutilus*, and *S. bramae* in *Blicca*, *Abramis* and *Vimba*.

In Poland I found *S. globiporum* sensu Szidat in *Misgurnus* and *Scardinius* at Drużno, in *Rutilus* at Lake Gołdapiwo, in *Rutilus* and *Scardinius* and their fry at Lake Mamry Północne and finally in *Rutilus* in Łacha Konfederacka in the Vistula near Płock.

Ślusarski (1958) found it in *Salmo* sp. in the Wda.

I found *S. bramae* sensu Szidat in *Blicca*, *Abramis* and *Esox* at Lake Drużno, in *Abramis* at Lake Gołdapiwo, in *Blicca* and *Abramis* at Mamry Północne and also in *Abramis* and *Vimba* in the Vistula.

I failed to establish a clear periodical occurrence of *S. bramae* and *S. globiporum*. True I always encountered incomparably more parasites in autumn and winter than in summer, but I cannot say whether this reflects any regularity.

I found no *S. bramae* or *S. globiporum* in summer at Mamry, where the invasion of fishes of higher age classes is high, although one-year-old fry was heavily invaded by them precisely at that time and Milicer (1938) had found *S. bramae* at Wigry in July and August.

It is interesting to notice that I observed the invasion by the non-typical form of *S. globiporum* only at Mamry, where the invasion of fishes of higher age-classes is considerable.

Družno is under-invaded. Very low percentage and intensity of invasion for *S. bramae* and *S. globiporum* (Table VIa) help classify these parasites as non-characteristic of Družno.

Genus *Asymphylogidora* Looss, 1899

Syn.: *Parasymphylogidora* Szidat, 1943

The genus *Asymphylogidora* with the typical species *Asymphylogidora perlata* Looss, 1899 was created by Looss in 1899. Lühe gave a comprehensive diagnosis of the genus in 1909. In 1911 Odhner created the subfamily *Proctotrematidae*, in which the genus *Asymphylogidora* occupied a fairly isolated position. In 1943 Szidat created the subfamily *Asymphylogidorinae* and assigned to it the genera *Asymphylogidora* Looss, 1899, *Parasymphylogidora* Szidat, 1943 and *Paleorchis* Szidat, 1943. Kulakowska and Tschernyschenko described two new species, *Asymphylogidora markewitschi* and *Asymphylogidora pontica* in 1947 and 1949, which combined features proper to the genus *Asymphylogidora* with some features regarded by Szidat as characteristic for the genus *Parasymphylogidora*. This makes Sobolev (1955) and Skrjabin (1955) to transfer the genus *Parasymphylogidora* Szidat, 1943 to the synonyms of the genus *Asymphylogidora* Looss, 1899. Thus species with a long and narrow excretory bladder were assigned to the genus *Asymphylogidora* with a pyriform small excretory bladder.

Of the many species of the genus *Asymphylogidora* I succeeded in observing only two, *A. tincae* Modeer, 1790 and *A. markewitschi* Kulakowska, 1947, in the lakes I explored.

Asymphylogidora tincae (Modeer, 1790)

We owe the first accurate description and drawing of the parasite to Looss, 1894. Szidat (1943) repeated this description and supplemented it with a minor observation concerning the relation of the size of the suckers.

The distribution of *A. tincae* covers the whole of Europe (Dawes, 1946; Markewitsch, 1951; Skrjabin, 1955). As a specific parasite of the intestine of *Tinca* it accompanies this fish everywhere.

As regards the previous Polish investigators, the fluke was found first by Kowalewski (1894, 1895) in *Tinca* from the Dniester and the ponds at Dublany, and then by Ruszkowski (1925) near Warsaw. Later it was observed by Milicer in *Tinca* and *Scardinius* from Lake Wigry. But as *A. tincae* (Modeer, 1790) seems to be a specific parasite of *Tinca* I believe that what Milicer found in *Scardinius* was another species, *A. markewitschi*, discovered in the intestine of *Carassius* from the Dniester and described by Kulakowska in 1947, and mistook it for *A. tincae*, thus committing the same mistake as I did at Lake Tajty.

I found *A. tincae* in the intestine of *Tinca* at Lakes Družno, Łabędzie, Tajty, and Oświn.

I established the periodical occurrence of *A. tincae* only in part. I encountered only young specimens in the intestine of *Tinca* in May. The parasites had eggs already in the uterus in July. The number of eggs rose in August and September. I was not able to find out in what month *A. tincae* left the host.

Asymphyiodora tincae occurred in the intestine of the host, usually by itself, probably because the specimens I examined were scantily invaded by other intestinal parasites. I found it once with *Monobothrium wegeneri*.

As the invasion percentage for *Tinca*, its only host, is fairly high (50%) and invasion intensity low (Table VIa), *A. tincae* may be regarded as a parasite not very characteristic of the Družno biocoenosis.

Asymphyiodora markewitschi Kulakowska, 1947

The fluke was observed in the intestine of *Carassius* from the Dniester. As *A. markewitschi* was found outside the USSR only in Poland, I repeat the description of this parasite as I observed it.

A. markewitschi resembles *A. tincae* in general appearance and movements. When at rest it assumes an oval shape tapering towards both ends. Its anterior part is covered with fine, not very dense spines which become over scantier and smaller towards the end and finally disappear completely. Suckers comparatively large, the oral being somewhat smaller than the ventral as a rule. As these organs are highly contractile this relation is not constant. Among the preserved, stained and mounted specimens I encountered some whose both suckers were almost equal. The alimentary tract begins with an oral opening situated terminally and

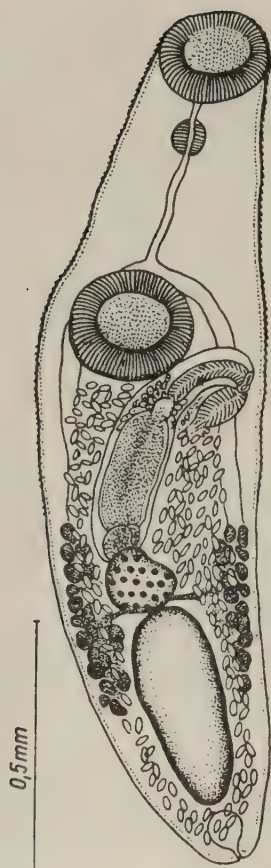


Fig. 16. *Asymphyiodora tincae* (Modeer, 1790) from intestine of *Tinca tinca* (L.).

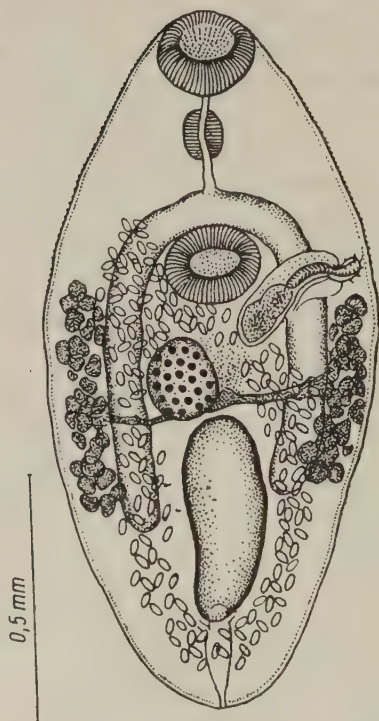


Fig. 17. *Asymphyiodora markewitschi* Kulakiwska 1947 from intestine of *Scardinius erythrophthalmus* (L.).

passing into a short prepharynx followed in turn by a wide, fairly short and well-muscled pharynx. The oesophagus branches in front of the ventral sucker into two thick branches reaching half way through the testes.

Male sexual organs: Testes oval, long, narrow, lying in the middle of the posterior part of the body. Cirrus sac not very well-muscled and small (almost twice as small as in *A. tincae*), beginning behind the ventral sucker and lying on its left; poorly visible when the seminal vesicle is not filled with sperm, as rightly pointed out by Kulakiwska (1949); containing a bipartite seminal vesicle, a short prostatic part and a cirrus covered with

relatively large but scanty spines. Cirrus capable of being extruded like a mace.

Female sexual organs: Ovary relatively small and almost spherical, lying in front of the testis and somewhat obliquely to it. Uterus thin-walled, descending behind the posterior limit of the testis, returning forwards and passing into a short spine-covered metraterm. Metraterm usually hidden under the cirrus sac, exiting like the ejaculatory duct, close to it on the left side of the body. Eggs very numerous, transparent and bright when young, yellow and brown when older, with a very small nodule lying somewhat aside of the posterior end. Operculum clearly visible in older eggs.

Vitellaria occurring as accumulations which, although undoubtedly characteristic of the species, are not so constant a feature of it as maintained by Kulakiewska. Sometimes they scatter into smaller or even very small accumulations, or are compact on the one side and scattered into single follicles on the other. The number of accumulations varies. They begin at the level of the hind extremities of the intestines and reach forwards as far as the hind limit of the ventral sucker. Vitelline ducts, right and left, meeting in the middle of the body, behind the ovary, into a common thicker reservoir.

In contradistinction from *A. tincae*, in which the excretory bladder is small and pyriform, the excretory bladder in *A. markewitschi* is a narrow and long canal. I was not able to notice its anterior part hidden under the testis and described by Kulakiewska.

I failed to establish the periodical occurrence of *A. markewitschi*. I observed mature specimens full of eggs in July, August, and September.

Asymphyrodora markewitschi occurred in the intestine of *Scardinius* either by itself or together with *Allocreadium isporum* (Mamry Północne). I found it together with very young forms of *Proteocephalus torulosus* in *Alburnus*, also at Mamry Północne.

Scardinius and *Alburnus* in Poland, and *Carassius* and some of the other Cyprinid species in the USSR, have so far been recorded as hosts of *A. markewitschi*.

Distribution: the USSR: the basins of the Dnieper, Dniester, Danube and Southern Bug; Poland: Lakes Družno, Łabędzie, Mamry Północne and Tajty.

A. markewitschi was found at Družno only twice in *Scardinius* (four specimens) and thus it may be regarded as a parasite rare in the parasitofauna. At Mamry Północne, invasion intensity in *Scardinius* was higher than 200 specimens per fish, invasion percentage being high.

Figures on *A. markewitschi* are shown below:

Asymphyiodora markewitschi Kulakiwska

Corporis longitudo: 0.925—1.388 mm, latitudo: 0.4—0.6 mm;
 Acetab. orale: longit: 0.138—0.206 mm, latit. 0.165—0.192 mm;
 Acetab. ventrale: longit. 0.157—0.197 mm, latit. 0.165—0.208 mm;
 Praepharynx: longit. 0.022—0.058 mm;
 Pharynx: longit. 0.077—0.098 mm, latit. 0.089—0.118 mm;
 Oesophagus: longit. 0.065—0.080 mm;
 Testis: longit. 0.276—0.315 mm, latit. 0.118—0.190 mm;
 Ovarium: longit. 0.118—0.192 mm, latit. 0.118—0.169 mm;
 Ova: longit. 0.021—0.027 mm, latit. 0.011—0.016 mm.

Genus *Azygia* Looss, 1899

A great variability of the shape, length to width relation, size and topography of the sexual organs in the flukes of the genus *Azygia* (Mantel, 1926) account for descriptions of many species which were recognized as synonyms on closer examination. Dawes (1947) recognized only one species, *Azygia lucii* (Müller, 1776) Lühe, 1909 for European continent and this gives rise to certain doubts as far as *Azygia robusta* Odhner, 1911 is concerned. Odhner in 1911 and a number of German authors recently recorded the occurrence of two species: *Azygia lucci* (Müller, 1776) and *Azygia robusta* Odhner, 1911 beside each other, *A. robusta* prevailing in *Salmonidae* and *A. lucii* occurring chiefly in *Esox*. Yet, it is impossible to regard, as Odhner (1911) believes, *A. lucii* as specific to *Esox* and *A. robusta* as occurring only in *Salmonidae*. Heitz (1917) and Ślusarski (1958) found *A. lucii* in *Salmonidae*, and Bauer (1948) detected *A. robusta* not only in *Salmonidae* but also in *Esox* from the Yenisei. I found one specimen coinciding with the description of *A. robusta*, sexually mature and normally developed, in *Esox* from Mamry Północne in 1956, and saw several of them in 1957. Yet the difference between *A. lucii* and *A. robusta* is so small that the question whether there are one or two *Azygia* species in the European and Asian continents will I think be decided only by a close investigation into their development cycles.

Azygia lucii (Müller, 1776) Lühe, 1909

The first perfect description and drawing of *A. lucii* from *Esox* came from Looss in 1894. On the basis of my own materials I present drawings and measurements of *A. lucii* and a drawings of *A. robusta* (?) from *Esox*, and measurements of one specimen of *A. lucii* from *Perca*, of one from *Lota* and one from *Silurus*.

The body length of the *A. lucii* specimens from *Esox* varies in my preparations from 8.83 to 22 mm. Oral sucker fairly triangular in shape, measuring 0.71×0.86 to 1.1×1.24 mm in diameter. Ventral sucker considerably smaller than the oral as a rule, measuring 0.55×0.67 to 0.79×0.88 mm. The relation of their dimensions is 1.36—1.55:1. Pharynx varying in size and shape, measuring 0.51×0.30 — 0.79×0.50 mm, its length to width relation being 1.36—1.70:1. Oesophagus short. Caeca almost reaching the end of the body.

Ovary smaller than the testes, flatter in front, hemispherical at the back. Testes either spherical or transversely or longitudinally oval. I met, though very seldom, specimens with the posterior testis shifted far backwards or with one testis. Vitellaria running on either side of the body, reaching forwards about two thirds of the distance between the oral sucker and the ovary and backwards somewhat behind the posterior level of the hind testis, both rows terminating at the same level or one of them being longer. Young eggs are colourless, old ones yellow, all longitudinally oval, and when mature surrounded with a transparent, jelly-like, corrugated screen swelling in water.

A sexually mature specimen of *A. lucii* from *Perca* does not essentially differ in the shape or the topography of the sexual organs from one form *Esox* and only looks smaller and somewhat shortened as it were. With the body length of 7.68×0.94 mm, the oral sucker is 0.62×0.70 mm, and the ventral 0.49 mm in diameter. The length of the pharynx larger than its width: 0.391×0.195 mm. In specimens from one-year-old *Perca* fry, body length 2.58×0.55 mm, oral sucker 0.23×0.20 mm, ventral sucker 0.15×0.14 mm, pharynx ovoidal, 0.158×0.086 mm.

In a sexually mature specimen from *Lota* 4.97×0.94 mm long the oral sucker was 0.58×0.64 mm. Pharynx cylindrical, measuring 0.36×0.23 mm. Topography of sexual organs as in *A. lucii*



Fig. 18. a — (?) *Azygia robusta* Odhner, 1911 from stomach of *Esox lucius* (L.), as drawn from a preparation by T. Rojek from Lake Mamry; b — *Azygia lucii* (O. F. Müller, 1776) from stomach of *Esox lucius* from Lake Mamry.
Fig. 19. *Azygia lucii* (O. F. Müller, 1776) from stomach of *Esox lucius* (L.) from Lake Družno.

from *Esox* and *Perca*, the body dimensions being even more shortened than in *A. lucii* from *Perca*. In very young specimens from *Lota* the relation between both suckers in size similar; pharynx as in sexually mature specimens with a greater length than its width.

In a very young specimen from *Silurus*, body length 2.19×0.57 mm, oral sucker larger than the ventral, 0.23×0.27 mm, ventral sucker 0.20×0.23 mm, pharynx 0.16×0.08 mm.

It follows from the above measurements that the essential difference between *A. lucii* from *Esox* and that from *Perca* and *Lota* consists, it seems, in smaller size and the apparent shortening of the whole body. On the other hand, the relation of the size of both suckers and the relation of the length of the pharynx to its width are both in sexually mature and very young specimens from all above mentioned fish species almost the same. The oral sucker is considerably larger than the ventral, and the length of the sucker always larger than its width.

Distribution. *Azygia lucii* is known as a parasite of mainly predatory fishes, above all of *Esox* from fresh waters of Europe, Asia and North America. The following are regarded as definite hosts in Europe and Asia: *Esox lucius* L., *Salmo trutta* L., *S. trutta* m. *fario* L., *Salmo hucho* L., *Salvelinus lepiechini* Gmel., *Lucioperca lucioperca* (L.), *Perca fluviatilis* L., *Acerina cernua* (L.), *Thymallus thymallus* (L.), *Lota lota* (L.), *Silurus glanis* L., *Leuciscus cephalus* (L.), *Rutilus rutilus* (L.).

Azygia was recorded by Polish authors as well. Kowalewski found it near Lwów and in the Dniester in 1896 and 1905 in *Perca*, Sinicyn in *Esox* near Warszawa in 1905 and Ruszkowski on a Warszawa market in 1925, Dąbrowska in the Vistula (1926) in *Lota*, Milicer at Lake Wigry in 1938 in *Lota*, Prost (1952) in the district of Lublin, and Ślusarski in *Salmo trutta* in the Dunajec and in *Salmo* sp. at Lake Wdzydze in 1958.

I found *Azygia lucii* in *Esox* and *Perca* at Lake Drużno, in *Esox* in the Vistula, in *Perca* and *Esox* at Lake Gołdapiwo, in *Esox*, *Perca*, *Lota* and *Silurus* at Mamry Północne, and also in one-year-old *Perca* fry at Lake Tajty. *A. lucii* lives in the stomach and oesophagus of the host. It is often found in the gill cavity in *Esox* where it penetrates after the death of the host as found by Szidat (1932).

The comparative low percentage of invasion in *Esox* and the very low percentage of invasion in *Perca* (Table VI) shows that *Azygia lucii* is a parasite not very characteristic of the Družno biocoenosis.

Genus *Phyllodistomum* Braun, 1899

According to Dawes (1946, 1947) the family *Gorgoderidae* consists of the subfamily *Anaporhutinae* Looss, 1901, with the genus *Probilotrema*, and of the subfamily *Gorgoderinae* Looss, 1899, with the genera *Gorgodera*, *Gorgoderina* and *Phyllodistomum*. Pigulewski rearranged the family *Gorgoderidae* in 1952 and created among others a new subfamily, *Phyllodistomatinae*; he divided the genus *Phyllodistomum* into a number of subgenera and split the typical representative of the genus *Phyllodistomum folium* (Olfers, 1917) into four independent species. Of these species only *Phyllodistomum (Phyllodistomum) folium* sensu Pigulewski was found at Družno. The anatomical structure (Fig. 20) and the measurements of the parasite roughly coincided with those given by Pigulewski.

Phyllodistomum (Ph.) folium (Olfers, 1817) Pigulewski,
1952

Body pyriform, elongate, flat, passing in front into the anterior narrower part. Posterior part oval. Cuticle smooth. Size usually varying from 1 to 2 mm, but there are far larger specimens. Oral sucker 0.168×0.157 mm; ventral sucker 0.258 mm in diameter. Vitellaria oval and whole-edged, lying vertically or almost vertically to the longitudinal axis of the body. Excretory bladder long and narrow. Testes vaguely lobar, the anterior somewhat larger than the posterior. Ovary with distinct incisions, lying opposite to the anterior testis and at its level. Uterine convolutions lying intracaecal and partly extracaecal, towards the back of the ventral sucker. Eggs $0.041-0.044 \times 0.025-0.033$ mm.

Typical parasite of the urinary bladder of *Esox*.

The distribution of *Ph. folium* is rather difficult to determine because of the changes in the taxonomy and synonymy of the species. It has been repeatedly recorded in Central Europe: by Olfers (1817) near Berlin, by Braun (1899) near Königsberg

(Królewiec), by Zandt (1924) at Lake of Constance, and by Nybelin (1926) near Uppsala. It has been recorded in various places of the European and Asiatic parts of the Soviet Union (according to Pigulewski).

Milicer was the first to find it in Poland (1938). Also reported on by Prost (1952). Seems fairly common. Outside Družno I found it both at Lake Gołdapiwo and Lake Mamry Północne. Non-characteristic of the parasitocenosis of Družno, where it has been found only once (Table VI).

Sanguinicola armata Plehn, 1905

I could not determine the definite form of this parasite because I did not examine the blood of the fishes at Lake Družno. On the other hand, I found eggs and mainly encysted larvae of *S. armata* in the gills and internal organs of *Tinca*. In view of a high invasion percentage and a fairly high invasion intensity *S. armata* may be regarded as a parasite fairly characteristic of the biocenosis of the lake.

I once found fairly many cysts containing larvae of the fluke, furnished with eye spots and resembling *Sanguinicola* larvae in appearance in *Abramis* and also many in *Aspius*.

CESTODA

(Tables VIII & IX)

Of the seven species of definite forms and five larval forms of *Cestoda* found at Družno, *Caryophyllaeus laticeps* (Pall.) and *Ligula intestinalis* (L.) proved characteristic, while others should be regarded as either little characteristic of, or rare in, the parasitocenosis of the fishes of the lake.

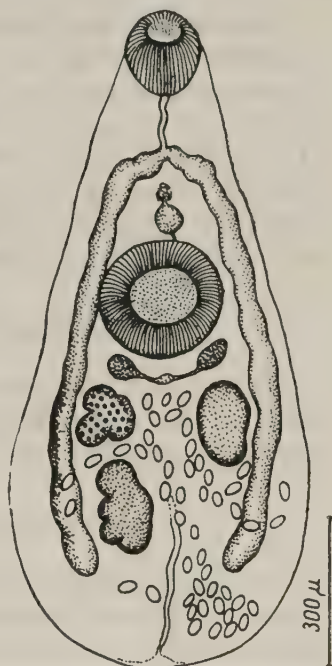


Fig. 20. *Phyllodistomum* (Ph.) *folium* (Olfers, 1817) from urinary bladder of *Esox lucius* from Lake Družno.

Caryophyllaeus laticeps (Pallas, 1781)

Syn.: *Caryophyllaeus mutabilis* Rudolphi.

The species was observed in the intestine of *Abramis*, *Blicca* and *Tinca*. The highest invasion was observed in *Abramis*, where it occurred either by itself or together with *Caryophyllaeides fennica* (Schneider, 1902), *Monobothrium wagneri* Nybelin, 1922 and *Sphaerostomum bramae* (Müller, 1776) Szidat, 1944. Considering its high invasion extensity and intensity and occurrence in three fish species common in the lake, *C. laticeps* may be regarded as a parasite characteristic of Družno.

Caryophyllaeides fennica (Schneider, 1902)

I found it in the intestine of *Abramis* and *Blicca*. Less characteristic of the parasitocoenosis of the fishes of Lake Družno than *Caryophyllaeus laticeps*.

Monobothrium wagneri Nybelin, 1922

Occurring more often in *Tinca*, less frequently in other species. I found it in the intestine of *Tinca* and *Abramis* at Družno. As its invasion extensity and intensity are low, it seems to be still less characteristic of the lake than *C. fennica*.

All the above three species were found in the intestine of fishes in spring, summer and autumn, both the extensity and intensity of invasion being higher in the spring time than in other seasons.

Triaenophorus nodulosus (Pallas, 1781) Rudolphi, 1793

Syn.: *Triaenophorus tricuspidatus* (Bloch, 1779).

One of the most common parasites of *Esox*, encountered also in other predatory fishes. I found its definite form in five out of the 63 *Esox* examined at Družno in 1950—51. It occurred in the intestine of the host either by itself or together with *Acanthocephalus lucii*, *Camallanus lacustris* and *Rhipidocotyle illense*. I could not establish the periodical occurrence of the parasite in the annual cycle at Družno. I only observed that only very young specimens occurred in July, August, and September.

The plerocercoid of *T. nodulosus* proved to be even less fre-

quent at the lake than the definite form of this tapeworm. I found it only twice in the liver of two out of the 58 *Perca* examined in 1950—51. As the percentage and intensity of invasion both by the definite and larval forms are low, *T. nodulosus* may be regarded as a parasite non-characteristic of the fish parasitocoenosis at Družno.

Eubothrium rugosum (Goeze, 1782)

Specific parasite of *Lota*. Five immature specimens of the tapeworm were found in the pyloric processes and the intestine of the only specimen of *Lota* examined at Družno.

Proteocephalus percae (O. F. Müller, 1780) La Rue, 1911

Found in the intestine of one of the 14 *Perca* examined in 1951 together with *Acanthocephalus lucii*. Little characteristic of the biocoenosis of the lake.

Proteocephalus filicollis Rudolphi, 1802

Syn.: *Proteocephalus ambiguus* Dujardin, 1845.

Strobile narrow, under 3 cm in length; apical sucker absent; cirrus sac short. Recorded so far in *Gasterosteus aculeatus* and *Pungitius pungitius* in Western Europe and the Soviet Union. I found it in two *Pungitius* examined at Družno in 1951.

Proteocephalidae, juvenile forms

Very young forms of *Proteocephalidae* were found twice, once in the intestine of *Perca* in March, the other time in the intestine of *Alburnus* in May. In the first case the presence of the apical sucker and the species of the host suggest that it was *Proteocephalus percae*; in the other, the absence of the apical sucker and the species of the host suggest the presence of *Proteocephalus torulosus*.

Diphyllbothrium latum (Linné, 1758)

Plerocercoids of *D. latum* were once found in the liver of *Perca* (one specimen), once in the body cavity in *Esox* (four specimens) and once in the liver in *Abramis* (three specimens). As the invasion extensity and intensity are low they may be regarded as non-characteristic of the lake.

Table VIII
Cestoda — invasion of adult fishes in 1950 and 1951

Host	Year	No. of fishes exam.	Caryophyllaeus laticeps					Monobothrium wagneri					caetera				
			Invasion	%	No. of parasites	Intensity	Index of invasion	Invasion	%	No. of parasites	Intensity	Index of invasion	Invasion	%	No. of parasites	Intensity	Index of invasion
Esox lucius L.	1950	29															
	1951	34															
Abramis brama (L.)	1950	26	13	50.0	42	1—10	3.2	3	11.5	4	1—2	1.3					
	1951	23	11	48.0	306	1—240	27.8	1	4.35	1	1	1.0					
Blicca björkna (L.)	1950	19	2	10.5	6	3	3.0										
	1951	6															
Tinca tinca (L.)	1950	16	1	6.25	9	9	9.0	1	6.25	18	18	18					
	1951	12	1	8.35	1	1	1.0	2	16.7	2	1	1.0					
Perca fluviatilis (L.)	1950	44									e						
	1951	14															
Pungitius pungitius (L.)	1950																
	1951	2															

Diphyllbothrium sp.

I found very young plerocercoids probably of the genus *Diphyllbothrium* or *Ligula* in the body cavity of one-year-old Cyprinid fry at Družno. I failed to denote them in detail.

Ligula intestinalis (Linné, 1758)

I observed plerocercoids of *L. intestinalis* between 1950 and 1953 in *Abramis*, *Blicca*, *Rutilus*, *Rhodeus*, *Alburnus*, and over-one-year-old *Blicca* fry. In view of a high percentage of invasion in five fish species common in the lake, *Ligula* may be regarded as a parasite characteristic of Družno.

Gryporhynchus sp. — cysticercus (Fig. 21 a & b)

I often found cysticercus-type larvae in the anterior part of the intestine in *Carassius* and *Misgurnus* at Družno and in both of them and *Tinca* and *Abramis* at Lakes Gołdapiwo and Mamry Północne. I could not assign those larvae to any of the tapeworms of the genus *Gryporhynchus* or *Dilepis* distinguished so far. The measurements of their hooks do not coincide with the cysticerci of *Gryporhynchus pusillae* Nordmann, 1832, recently described again by Dubinin (1952) or with the cysticerci of *Gryporhynchus cheilancristrotus* (Wedl, 1855) discovered by Dubinin (1952) in the gall bladder of *Tinca* and *Scardinius*. What they resemble comparatively most is the larva described by Wägener (1857) as *Gryporhynchus* sp. and reported by Joyeux (1936) as the cysticercus *Gryporhynchus cheilancristrotus* (Wedl, 1855). I believe that the species of the larvae I found will be decided only when more of them are examined and the development cycle of *Gryporhynchus pusillus* Nordmann determined. At the moment I describe them as *Gryporhynchus* sp. — cysticercus.

The length of a larva with a fully everted scolex and a straightened rostellum amounts to 6.2 mm. Body elongate, pyriform, tapering towards the end, tightly packed with large calcary bodies. Scolex possessing four powerful suckers. Rostellum with a double ring of hooks unequal in length, arranged in pairs. One hook of each pair 0.053 mm long, the other 0.039 mm long. The number of larvae in a fish varying from one to several specimens. Larvae moving slowly in the mucus of the intestine, everting and inverting the scolex alternately.

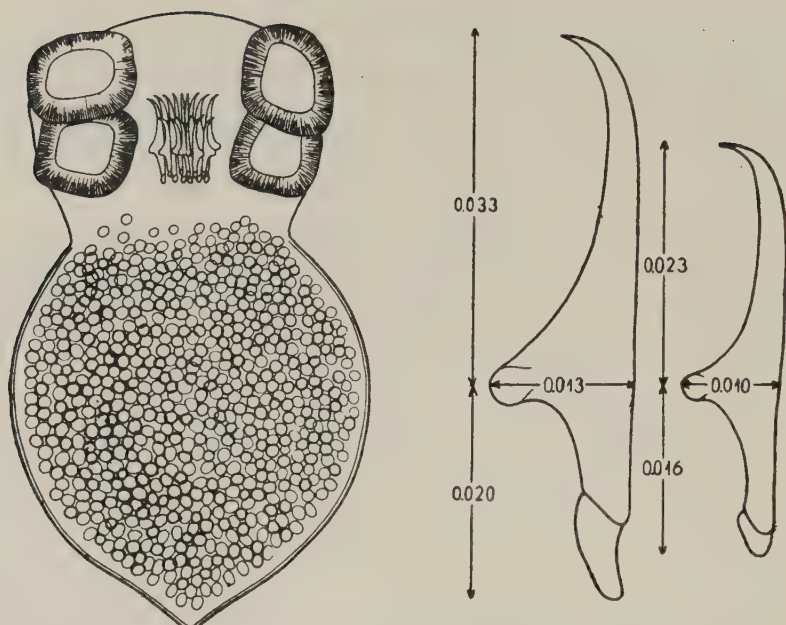


Fig. 21. Cysticercus of *Gryporhynchus* sp. from intestine of *Carassius carassius* (L.); a — habitus; b — hooks.

NEMATODA

(Table X)

Almost exclusively definite forms of this group were taken into consideration. Encysted larvae were not sampled, counted or taken account of in tables. Neither is the percentage of the occurrence of unencysted nematode larvae found in the vitreous humour of the fish eye given, since they were very small and extremely mobile and therefore could have been left unnoticed.

Of the definite nematode forms, only *Camallanus lacustris* proved to be characteristic of the lake, the rest should be regarded as species either non-characteristic of, or rare in, Družno.

Rhaphidascaris acus (Bloch, 1779)

Common intestinal parasite of *Esox*, also found in other predatory fishes. Found in *Esox* and *Anguilla* at Družno. In view of a low percentage of invasion it may be regarded as a parasite non-characteristic of the lake.

Camallanus lacustris (Zoega, 1776)

Found in the alimentary tract of *Perca*, *Lucioperca*, and *Acerina*, once in *Scardinius* and several times in one-year-old Cyprinid fry. Occurred in adult fishes either by itself or together with *Bucephalus polymorphus*, *Rhipidocotyle illense* or *Acanthocephalus lucii*. *Perca* was most heavily invaded and it seems to be its main host. As five fish species common at Družno were invaded by it and invasion extensity in *Perca* and *Esox* was relatively high, it may be regarded as a parasite fairly characteristic of Lake Družno.

Philometra opercularis Nybelin, 1931

Only one large mature female of *P. opercularis* full of its larvae was found under the operculum of *Abramis* at Družno. This species, rare and perhaps accidental at Družno, is common in the mid Vistula, where it was found fairly often in *Abramis* and *Blicca*. Skrjabin (Markewitsch, 1951) thinks *P. opercularis* to be identical with *P. rischta* Skrjabin, 1917.

(?) *Desmidocercella numidica* (Seurat, 1920) Yorke et
Maplestone, 1926

I found very small nematode larvae under 1 mm in the vitreous humour in *Perca*, *Abramis*, *Scardinius* and *Blicca* at Družno and a number of other lakes. They were first recorded in Poland. They were first described by Dogiel (1938) in the Caspian Sea, and then by Dubinin (1952) in the Volga delta. Dogiel denotes them as belonging to the genus *Desmidocercella*, and Dubinin, on the basis of the structure and an experimental invasion, defines them as *Desmidocercella numidica*. As I was unable fully to eliminate these larvae and analyse their structure in detail, I assume their identity with the species described by Dubinin only on the basis of their localization (the vitreous humour of the eye) and size, as well as a characteristic swelling at the body end. Mature form, parasitic in the airsacs of heron, first recorded in Poland by Bezubik (1956).

Table IX.

Gestoda — larval forms (plerocercoids) — invasion of adult fishes in 1950 and 1951

Host	Year	No. of fishes examined	<i>Ligula intestinalis</i> (L.)					caetera				
			Invaded	%	No. of parasites	Intensity	Index of invasion	Invaded	%	No. of parasites	Intensity	Index of invasion
<i>Esox lucius</i> (L.)	1950	29						<i>Diphyllbothrium latum</i> (L.)				
	1951	34						1		4		4
	1955	1										
<i>Abramis brama</i> (L.)	1950	26	5	19.2	8	1-4	1.6	<i>Diphyllbothrium latum</i> (L.)				
	1951	23						1	4.35	3	3	3.0
<i>Blicca björkna</i> (L.)	1950	12	5	26.3	28	1-23	5.6					
	1951	9	1	11.1	2	2	2.0					
<i>Rutilus rutilus</i> (L.)	1950	27	1	3.7	2	2	2.0					
	1951	23										
<i>Alburnus alburnus</i> (L.)	1953	50	16	32.0	20	1-2	1.3					
<i>Carassius carassius</i> (L.)	1950	9						<i>Cysticercus</i> of <i>Gryporhynchus</i> sp.				
	1951	6						3	33.0	5	1-3	1.6
<i>Rhodeus sericeus</i> (Pall.)	1950							4		26	2-14	6.5
	1951	18	13	72.2	33	1-9	2.7					
<i>Misgurnus fossilis</i> (L.)	1951	2						<i>Cysticercus</i> of <i>Gryporhynchus</i> sp.				
								1		15	15	15.0
<i>Perca fluviatilis</i> (L.)	1950	44	<i>Triaenophorus nodulosus</i> (Pall.)					<i>Diphyllbothrium latum</i> (L.)				
	1951	14	2	4.6	2	1	1.0	1				
<i>Blicca björkna</i> (L.) — fry	1951	41	2	14.3	2	1	1.0	1	7.1	1	1	1.0
			<i>Ligula intestinalis</i> (L.)									
			24	58.5	33	1-3	1.4					

Table X

Nematoda — invasion of adult fishes in 1950 and 1951

[illegible]

ACANTHOCEPHALA

(Table XI)

Acanthocephalus lucii (Müller, 1787) Lühe, 1911Syn.: *Echinorhynchus angustatus* Rudolphi, 1809.

A. lucii, very common in other lakes as well, was found at Družno in the intestine of *Perca*, *Acerina*, *Anguilla*, *Tinca*, and *Abramis*. It occurred in those fishes either by itself or together with other ordinary intestinal parasites. *Perca* proved to be most heavily invaded and seems to be its main host. In view of its presence in five fish species common at the lake and a high invasion intensity in *Perca* and *Esox*, it may be regarded as a parasite fairly common at Družno.

Acanthocephalus anguillae (Müller, 1787) Lühe, 1911Syn. *Echinorhynchus globulosus* Rud., 1809.

A. anguillae, fairly common in fishes in the mid Vistula was found only once at Družno, in the intestine of *Tinca*. Rare in the fish parasitocoenosis of the lake.

Corynosoma strumosum (Rud., 1802)Syn. *Echinorhynchus ventricosus* Rud., 1809; *E. gibbosus* Rud., 1809; *E. hystrix* Bremser in Rud., 1819; *E. gibber* Olss., 1893.

I found four immature specimens of *C. strumosum* on one occasion in the intestine of *Esox*. As a marine element, biologically alien to fresh waters, the parasite is an alien and accidental element in the fish parasitocoenosis of Lake Družno.

Neoechinorhynchus rutili (Müller, 1780)Syn. *Echinorhynchus clavaeiceps* Zeder, 1800; *Neorhynchus clavaeiceps* Zeder, 1780; *E. tuberosus* Zeder, 1803.

I found only one specimen of this species in the intestine of *Abramis* at Družno. It was a young female full of eggs. Body of the parasite bent archwise on to the ventral side, 3.85 mm long, 0.45 mm wide. Proboscis, almost spherical, furnished with 18 hooks, 0.14 mm wide. Large terminal hooks 0.08 mm long. Five huge testes on the central dorsal line, one on the sagittal ventral line, two in the longer lemniscus and one in the shorter lemniscus.

Table XI
Acanthocephala — invasion of adult fishes in 1950 and 1951

[illegible]

HIRUDINEA

I found only *Piscicola geometra* in fishes from Družno Lake. I observed masses of it in the branchial cavity in *Esox* at low water in winter.

MOLLUSCA

Glochidia *Anodonta* sp.sp. occurred in 11 fish species at Družno. Invasion percentage in various species varied from 4 to 33, intensity amounted to up to 145 specimens on both sides of the gills.

CRUSTACEA

(Table XII)

Ergasilus sieboldi Nordmann, 1832

I found it in seven fish species. *Tinca* proved to be most heavily invaded, *Esox* being second to it. In view of the occurrence of the parasite in seven fish species common in the lake, high invasion extensity and very high invasion intensity in *Tinca*, *E. sieboldi* may be regarded as one of the dominant components of the fish parasitocoenosis at Lake Družno.

Achteres percarum Nordmann, 1832

The species was found in *Lucioperca* and *Perca* at Družno, the latter proving far less invaded than the former. Little characteristic of the fish parasitocoenosis of the lake.

Argulus foliaceus (L., 1758)

I found it several times in *Perca* and *Abramis*. As this parasite often abandons caught fish, I do not state its invasion intensity or percentage of occurrence.

I think it a pleasant duty of mine to extend my thanks to all who have helped me with my research at Družno. I thank Prof. Wiśniewski for entrusting me with the treatment of fish parasites of the lake and for his valuable guidance in the course of my work, Prof. Konopacka and Prof. Szwejkowski for their perusal of my pathological material, Dr. W. Ślusarski for the comrade-like help he offered to me in my work on flukes and for drawing the parasites for me, and Dr. Osuchowska for drawing the histopathological figures.

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STRESZCZENIE

Badania pasożytów ryb jeziora Družno prowadziłam w latach 1950—1953, w miesiącach letnich: lipiec, sierpień, wrzesień, oraz w ciągu 10 dni w maju i w listopadzie. Zasadniczym ich zadaniem było ustalenie, które gatunki pasożytów są dla biocenozy jeziora Družno typowe i ilościowo dominujące, a które są dla

nich uboczne lub przypadkowe, oraz wykazanie okresowych zmian w występowaniu pasożytów.

Pasożyty znalezione w rybach należą do *Myxosporidia*, *Ciliata*, *Monogenea*, *Digenea*, *Cestoda*, *Nematoda*, *Acanthocephala*, *Hirudinea*, *Copepoda parasitica* i *Mollusca* (glochidia). Skład poszczególnych komponentów parazytocenozy ryb ustalano na podstawie ilościowego występowania pasożytów. Miernikiem zarażenia była ekstensywność i intensywność zarażenia; ekstensywność i wskaźnik zarażenia były podstawą do wyróżnienia wśród pasożytów elementów pospolitych i ubocznych. Do pospolitych pasożytów ryb jeziora Drużno należą przywry, zwłaszcza postacie larwalne *Digenea*, z tasiemców — *Caryophyllaeidae*, z larw tasiemców — *Ligula* sp., z *Copepoda parasitica* — *Ergasilus sieboldi*. Do elementów ubocznych należą *Protozoa*, *Acanthocephala*, *Nematoda* i inne tasiemce poza wymienionymi.

Podaję poniżej wyniki moich badań dotyczących charakteru i stanowiska znalezionych pasożytów w biocenozie jeziora Drużno.

Myxosporidia (tab. III)

Z pierwotniaków, pasożytujących u ryb jeziora Drużno, wysuwają się one na pierwsze miejsce. Niewielka intensywność i ekstensywność inwazji pozwala je uważać za niezbyt charakterystyczne dla biocenozy jeziora Drużno.

Ciliata (tab. IV)

Spośród orzęsków: *Ichthyophthirius multifiliis* Fouquet, 1876, *Tridochina domerguei* Wall., 1897 i *Trichodinella epizootica* (Raabe, 1950) można uważać za mało charakterystyczne, zaś *Chilodonella cyprini* (Moroff, 1902) i *Trichodina urinaria* Dogiel, 1941 — za rzadkie w biocenozie jeziora. Poza nimi na skrzelach ryb wyrosniętych oraz na skrzelach i w jamie gębowej narybku stwierdzono *Glossatella* sp.

Monogenea (tab. V)

Spośród *Monogenea* — rodzaj *Dactylogyrus* można uważać za dosyć charakterystyczny, rodzaj *Gyrodactylus* — za rzadki; gątniki: *Tetraonchus monenteron* (Wagner, 1857) Diesing, 1858 i *Diplozoon paradoxum* Nordmann, 1832 — za mało charakterystyczne, a *Ancyrocephalus paradoxus* Creplin, 1838 — za rzadki dla parazytocenozy ryb jeziora Drużno.

Digenea (tab. VI i VII)

Bucephalus polymorphus Baer, 1827 i *Rhipidocotyle illense* (Ziegler, 1883) Vejnár, 1956 były dominującymi przywrami na Družnie. *Rh. illense* występowało na jeziorze masowo; jego postać ostateczną znajdowałam w liczbie do paru tysięcy w jelicie *Esox lucius*, nieliczne u *Perca fluviatilis* i u *Acerina cernua*, zaś metacerkarie w skórze, płetwach i mięśniach 11 gatunków ryb, u niektórych masowo. *B. polymorphus* był na jeziorze rzadszy; jego postać ostateczną znajdowałam w ilości do kilkunastu egzemplarzy w jelicie *Lucioperca lucioperca*, a pojedynczo i bardzo rzadko w jelicie *Esox lucius*, zaś metacerkarie znalazłam raz w płetwie *Blicca björkna*. Na podstawie swego materiału i w oparciu o literaturę przeprowadzam dyskusję na temat odrębności tych gatunków i przedstawiam ich różnicujące opisy.

Allocreadium isoporum (Looss, 1894) znalazłam na Družnie u *Esox lucius* i *Carassius carassius*. Niewielka ekstensywność i intensywność inwazji pozwala je zaliczyć do pasożytów nie charakterystycznych dla parazytocenozy ryb jeziora Družno.

Bunodera luciopercae (O. F. Müller, 1776) spotykałam na Družnie u *Perca fluviatilis*, *Lucioperca lucioperca*, *Acerina cernua* i *Esox lucius* i stwierdziłam okresowość jej występowania. Zarażenie czterech gatunków ryb oraz duża ekstensywność i intensywność występowania *B. luciopercae* w miesiącach wiosennych i jesiennych pozwala ją uważać za charakterystyczną dla biocenozy jeziora.

Rodzaj *Sphaerostomum* reprezentowany był przez *S. globiporum* (Rud., 1802) Szidat, 1944 i *S. bramae* Müller, 1776, a więc gatunki nie odróżniane dotychczas przez niektórych autorów. *S. bramae* znalazłam na Družnie u *Abramis brama* i *Blicca björkna*, *S. globiporum* u *Misgurnus fossilis* i *Scardinius erythrophthalmus*. Oba gatunki (tab. VIa) okazały się dla Družna niezbyt charakterystyczne.

Asymphylogadora tincae (Modeer, 1790) Lüh e, 1909 występowała z niewielką ekstensywnością i intensywnością zarażenia u *Tinca tinca*. Pozwala to ją uważać za niezbyt charakterystyczną dla parazytocenozy ryb tego jeziora.

Asymphylogadora markewitschi Kulakiwska, 1947, gatunek nowy dla Polski, spotkałam u *Scardinius erythrophthalmus*. Niewielka ekstensywność i intensywność zarażenia klasyfikuje tę przywrę jako mało charakterystyczną dla tego jeziora.

Azygia lucii (O. F. Müller, 1776) Lühe, 1909 znalazłam na Drużnie u *Esox lucius* i *Perca fluviatilis*. Niewielka intensywność i stosunkowo niewielki procent zarażenia szczupaka pozwala ją uważać za mało charakterystyczną dla parazytocozy jeziora.

Phyllodistomum (Ph.) *folium* (Olfers, 1816) Pigulewski, 1952 znalazłam tylko raz w liczbie 50 osobników w pęcherzu moczowym *Esox lucius* — gatunek rzadki dla jeziora.

Sanguinicola armata Plehn, 1905 — jaja i larwy znajdowałam na Drużnie w skrzelach i narządach wewnętrznych *Tinca tinca*. Na podstawie dość dużego procentu i intensywności zarażenia można ją zaklasyfikować jako dość charakterystyczną dla parazytocozy ryb na Drużnie

Cestoda (tab. VIII i IX)

Ze znalezionych na jeziorze Drużno tasiemców, jedynie *Caryophyllaeus laticeps* (Pall., 1787) i *Ligula intestinalis* (L., 1758) — można uważać za pospolite. Pozostałe gatunki (p. tabela) są w jeziorze bądź rzadkie, bądź mało charakterystyczne dla jego parazytofauny.

Nematoda (tab. X)

Ze znalezionych nicieni *Camallanus lacustris* (Zoega, 1776) jest charakterystyczny dla biocozy Drużna, inne są mało charakterystyczne, a *Philometra opercularis* Nybelin, 1921 jest prawdopodobnie elementem przypadkowym.

Acanthocephala (tab. XI)

Spośród kolcogłówów za charakterystyczne można uważać *Acanthocephalus lucii* (Müller, 1787), za rzadkie — *Neoechinorhynchus rutili* (Müller, 1787), zaś *Corynosoma strumosum* (Rud., 1802) — za element obcy i przypadkowy.

Hirudinea

Na Drużnie stwierdzono *Piscicola geometra* (L., 1758).

Mollusca

Glochidia *Unionidae* sp.sp. zanotowano u 11 gatunków ryb — są one pospolite.

Crustacea (tab. XII)

Ergasilus sieboldi Nordm., 1832 występował na Drużnie z dużą ekstensywnością i bardzo wysoką intensywnością u *Tinca tinca* oraz u 6 innych gatunków ryb, co pozwala uważać go za gatunek dominujący w parazytocenozie ryb Drużna. Drugi gatunek — *Achteres percarum* Nordm., 1832 jest dla jeziora mało charakterystyczny. *Argulus foliaceus* (L., 1758) znalazłam u *Perca fluviatilis* i *Abramis brama*.